TRANSCRIPT OF PROCEEDINGS *

HEARING OF THE SUBCOMMITTEE ON AIR POLLUTION
AND RADIATION PROTECTION OF THE

ASSEMBLY INTERIM COMMITTEE ON PUBLIC HEALTH
W. BYRON RUMFORD, CHAIRMAN

October 10, 1961
Room 115, State Building
Los Angeles, California

COMPOSITION OF MOTOR FUELS, USE OF FUEL ADDITIVES AND THEIR RELATION TO THE CREATION OF SMOG

Howard J. Thelin, Subcommittee Chairman
Members, Ronald Brooks Cameron
Milton Marks
W. Byron Rumford
Chet Wolfrum

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SUBCOMMITTEE ON AIR POLLUTION AND RADIATION PROTECTION

Hearing held 10:00 a.m., Tuesday, October 10, 1961
Room 115, State Building, Los Angeles

CHAIRMAN THELIN: The meeting will come to order. This is a meeting of the Subcommittee on Air Pollution and Radiation Protection of the Public Health Committee. For the benefit of the audience, I would like to introduce the members of the Committee who are here today. On my extreme right is Assemblyman Ronald Cameron of Whittier; next to him we have Assemblyman George Brown. Mr. Brown is not a member of the Committee, but he is the author of the resolution which has led to the meeting that we are holding today. On the left of Mr. Brown is Assemblyman Byron Rumford, who is the Chairman of the parent Committee of this Subcommittee, the Public Health Committee. Mr. Rumford is from Alameda County. On my left is Mrs. Nance who is our Committee Secretary; and on her left is our Intern, Mr. Poschman.

I have received a letter from a Mr. Ralph Rutledge, a citizen who wanted to be here today to testify but who had to leave this area. His letter deals with air pollution, and in general, he feels that white gasoline is the solution. I am going to file his letter with the Committee.

This meeting is held in obedience to a House Resolution enacted at the last session of the Legislature, House Resolution 411. That Resolution directed that the appropriate interim committee study the subject of the composition of motor fuels and the use of fuel additives and their relationship to smog. The purpose

of our meeting then is to secure factual information which will help the Public Health Committee in its study of the composition of motor fuel and the use of additives and their relation to air pollution. The Subcommittee has specifically requested witnesses to address themselves generally to these questions. What kind of additives and how much of them are placed in motor fuel today? Do they contribute to air pollution? Are they a menace to public health? Can we eliminate substantial amounts of vehicle exhaust by a change in the composition of motor fuel? Should we restrict or prohibit the use of additives in fuels? I wish to stress that the Subcommittee will not make a decision today on any of these matters and no votes will be taken. We seek only, I repeat, factual information for the use of the Public Health Committee in evaluating the need for or the type of legislation which may be required. As always we are faced with limitations on our time. Therefore, we ask witnesses, if possible, to avoid repetition. We hope to give everybody approximately 20 minutes. Undoubtedly the Committee will have questions for most of the witnesses, thus, the direct testimony will be elaborated on in most cases by questions.

I wish to stress that anyone who wishes to file a written statement with the Committee may do so. These statements will be considered as we evaluate the testimony. It is not necessary to testify verbally in order to file a written statement with the Committee.

As our first witness today, I wish to call Mr. John Maga, Chief, Bureau of Air Sanitation for the State Department of Public Health. Mr. Maga, will you state your name and your position for the benefit of the record, please?

MR. JOHN MAGA: I am John Maga, Chief of the Bureau of Air Sanitation, State Department of Public Health.

Mr. Chairman and members of the Assembly Standing Committee on Public Health and Assemblyman Brown, I am here to make the presentation upon this subject. In addition, Dr. John Goldsmith, head of our medical studies in the air pollution field is also present and who can answer questions from the Committee on the health aspects of this problem if I am not able to do so. The Department has already completed two reports in the general area of motor vehicle fuel composition and additives, first of which was entitled, "Report on the Hazards to Health and Safety from Gas and Diesel Fuel", and was submitted to your Committee in accordance with the request of Assembly House Resolution 259. The second report which is being submitted is entitled, "Health Facts of Motor Vehicle Exhaust", and this is a presentation that was made by Dr. Goldsmith before the Motor Vehicle Pollution Control Board in August of this year. Copies of these reports are included with this statement, as they pertain to the subject under consideration by this Committee.

Gasoline, diesel fuel and liquefied petroleum gas (LPG) are the fuels that are used for motor vehicles in California. The amount of liquefied petroleum gas is a very small percent of the total sold. Last year it was approximately one-half of one percent of the gasoline sold. In 1960, for example, some 5,700,000,000 gallons of gasoline were sold, approximately 280,000,000 gallons of diesel fuel and some 25,600,000 or so of liquefied petroleum gas. Table 1, which follows page 13 of this, lists the amount of gasoline and liquefied petroleum gas distributed in California

and also diesel fuel used for the period 1955 to 1960. This follows page 13. Figures show that there has been a continuous increase in fuel consumption which has followed the increase in motor vehicle use in California.

It is interesting to point out that while the amount of diesel fuel used totals about 20% as much as gasoline, gasoline is used by some 7,700,000 vehicles in California, which the diesel fuel is used by approximately 27,000 trucks and buses, so that the amount of fuel used by diesel trucks and buses per vehicle is much greater than the amount of gasoline used by the individual car.

Fuel composition consists of a mixture of a large number of hydrocarbons and small amounts of other substances. The composition of these fuels may be quite variable depending upon the source of the crude, the refining processes and marketing requirements.

The hydrocarbons in gasoline are usually grouped into three classes: the parafines, the olefins and the aromatics. Because the olefins are the most reactive chemically, it has been suggested that limiting these compounds in gasoline would reduce the potential for "smog" formation. Table 2 which is again at the end of this thing, following Table 1 after page 13, lists the analysis of hydrocarbonsby their content aromatics and olefins and saturated fuels in California - of, pardon me, this is specific for the Los Angeles and San Francisco Bay Area for the years 1955 through 1960. This data has been obtained from the annual gasoline quality survey of the Ethyl Corporation. You can see down in 1960, for instance, that the mean olefin content in Los Angeles was 11%, in San Francisto was 21% for premium and regular, mean olefin was 12 in Los Angeles and 19 in San Francisco.

Fuel composition, of course, could refer to other than olefin content. It might also refer to sulphur content in both gasoline and diesel fuels, even other characteristics of gasoline. It might even be applied to the composition of diesel fuel, since the qualities of these fuels influence the smoke and odor from diesel exhaust to some extent.

Now a number of additives are used in motor vehicle fuel to improve the fuel and the operation of the engine. Additives are used to a lesser degree in diesel fuel than in gasoline. A complete list of the kind and amounts of additives is not available to the Department as there is no systematic compilation of this information in California. Competitive significance of additives in the marketing of fuels discourages publication of this information and the Department does not analyze fuels to determine either their composition or the additives.

The greatest concern over additives has been about lead and larger quantities of lead are used than any other additive. The amount of lead in gasolines sold in Los Angeles, San Francisco and Bakersfield for the years 1955 to 1960 in shown in Table 3. The quantity of lead added to each gasoline has not changed greatly over this five-year period. However, it should be pointed out that the total quantity of gasoline during this five-year period has increased considerably. As you can see in 1960 the amounts of tetra-ethyl lead used were all under 3 ML for the various areas and ranged from 2.99 for premium in Bakersfield down to 1.41 for regular gasoline in San Francisco.

Now in 1925 the Surgeon General of the U. S. Public Health Service convened a conference on the public health aspects of

tetraethyl lead (TEL). Since then there has existed a voluntary agreement between the manufacturers of tetraethyl lead and the various segments of the industry concerning the maximum amount which could be used. Because of this and other agreements between the industries, there has not been a great demand for State and Federal laws concerning the hygienic aspects of TEL.

The maximum amount of lead that was added until recently - that could be added was 3.0 milliliters per gallon. Now in November of 1958, the president of the Ethyl Corporation asked the guidance of the Public Health Service again on the question of increasing the maximum from 3.0 to 4.0 milliliters per gallon. An expert committee was convened on January 8 and 9, 1959, to consider this question.

The committee pointed out that "a conclusive answer is impossible at the present time because of the lack of medical data", but that, "available data do not indicate that the increase would significantly increase the hazard to the public health from air pollution."

As you can see from that Table, although the amount permitted to be added to gasoline now is 4.0 ML per gallon, this has really not amounted to much of a change to TEL used in California gasolines in San Francisco, Los Angeles and Bakersfield.

In 1960 a new additive, tetramethyl lead, TML, was introduced and marketed. This compound is more volatile than TEL and hence there is perhaps a greater inherent hazard to those handling gasoline. The exhaust emissions from these two compounds, however, would be the same.

All of the lead that is added to gasoline is not discharged into the atmosphere in particle sizes that are those that

would be inhaled. Much of the lead is in fairly large particles that settles out and is not inhaled, while organic lead compounds are added that emitted from the exhaust is predominately inorganic lead. Now although some of the lead in the atmosphere comes from other sources than motor vehicles, the lead in gasoline is believed to be a major source of atmospheric lead in California. This belief is supported by studies of the lead content of the air near freeways, within the communities, also from the knowledge of the large amounts of lead discharged from the motor vehicle and investigators studying the problem of lead, carbon monoxide and traffic have correlated these factors in several places in the United States.

Table 4 includes the atmospheric lead concentrations in several cities in the United States and in California. Los Angeles, we have found, has some of the highest lead levels in the country. You can see in the upper table that the average value for Los Angeles is 3.6, that for Pasadena is 3.2, that for Houston 3.3, Detroit 2.4 and so forth. The San Francisco one of 0.1 may raise some question because it is a rather low value. I must point out that this is a limited number of samples and probably the value is influenced by the sample location and the number of samples.

The second, the lower table, on the left hand side, results have been obtained by the California State Department of Public Health which indicate that the Los Angeles values are 3.5 as an average, San Diego 1.3, Berkeley 1.0, Mt. Hamilton 0.1. This indicates that there is a range in California cities probably somewhat related in size in traffic patterns and that a rural area, Mt. Hamilton has a very low value for lead.

The role of gasoline composition and additives in air pollution is dependent upon the source, nature and amount of emissions from motor vehicles and it might be well to relate fuel composition on the losses from the motor vehicle.

The evaporative losses occur from the fuel tank and carburetor. This is the evaporation of the gasoline and other volatile compounds. You then expect that the hydrocarbons lost from this source would be very similar to the fuel composition as this is merely the evaporation of the fuel. So that hydrocarbons are the important pollutant here and they would be similar to fuel.

In crankcase vent emissions, somewhat similar conditions exist and this emission is mainly an air-fuel mixture that is discharged from the engine or from the crankcase vent. It contains a small amount of exhaust products. Hydrocarbons are again the significant pollutants here because they are an unburned air-fuel mixture. They would be representative of the fuel composition. Once again this is merely gasoline that is being mixed with air that is being discharged into the atmosphere.

Now exhaust emissions, however, consist of products that are formed in the composition and the combustion of the fuel within the engine. This occurs under high temperature and high compression and there is a marked change in the pollutants that are emitted. In addition to hydrocarbons there are large quantities of carbon monoxide, of oxides of nitrogen, lead compounds and sulfur dioxide. Some of the hydrocarbons have been oxidized to compounds such as aldehydes, which may cause irritation and odor. The high temperature and high compression of the engine produces olefinic hydrocarbons even from gasolines which originally did

not contain this class of compound. Because most of the fuel has undergone changes, the hydrocarbons in the exhaust are no longer similar to those in the fuel. There has been a change so that the exhaust hydrocarbons are not now similar in all respects to the gasoline as was the case for the evaporative losses, for example. Estimates of the emission from all motor vehicle sources indicates that the exhaust is responsible for most of the hydrocarbons and the olefins, so that the exhaust, now, in addition to being somewhat different than the gasoline is also responsible for most of the hydrocarbons that are discharged and most of the olefins.

Now the improvement in air pollution that might be expected from the use of gasolines containing small amounts of olefins would be related to the anticipated decrease in the atmospheric concentration of the olefinic hydrogens. In other words, you could expect an improvement in air pollution resulting from the change in the fuel that would be characterized by decreasing olefins, you would anticipate this would be related to how much olefins are reduced in the atmosphere as a result of this. This decrease, of course, would depend on the relative proportion of the olefins lost to the atmosphere from the evaporative losses, crankcase vents and the exhaust. It has been indicated previously that the major source of olefins as well as other hydrocarbons are the exhaust and that these are not similar to the fuel. Therefore, fuel composition alone, through regulation of olefins could not be expected to solve the problem of motor vehicle created air pollution. Changes in gasoline composition would have very little, if any, effect on the other emissions from the exhaust such as oxides of nitrogen, carbon monoxide and

aldehydes, since there is no consideration here that changing of fuel would change the amount of these substances that would be produced in the exhaust.

Now the reduction of sulfur in fuels would, of course, decrease the amount of sulfur dioxide emitted from the exhaust. However, motor vehicles are not a major source of sulfur dioxide in California and recent findings, however, indicate that the formation of aerosols in this "smog" reaction depends upon the presence of sulfur dioxide and it may be possible in the future that some thought will have to be given to the need of the regulation of sulfur dioxide in order to prevent aerosol formation, but not to prevent or decrease the atmospheric concentration of sulfur dioxide in California communities.

The next general subject will be the health hazards and health effects from motor fuel and related air pollution. Irritation of the eyes and of the respiratory tract is the most widespread and disturbing symptom of air pollution in California. At least three-quarters of the persons in Southern California are bothered by eye irritation and as many as a hundred thousand persons throughout the state have reported in population surveys that air pollution bothers them by interfering with their breathing.

A variety of research programs have attempted to see whether or not irritating pollutant actually is responsible for new disease or new episodes in established diseases. There is some evidence that persons with far advanced respiratory diseases do, in fact, have interference with lung function from photochemical air pollution.

Despite a number of studies on the problem and the widespread effects on public health and well-being, there is no evidence so far that photochemical pollution harms human health in a sense of producing new disease. The major hazard to public health seems to be the possibility that long-continued exposures to irritating pollutants may cause such diseases as lung cancer and other chronic lung diseases. There is also the possibility that the irritating pollutants under extraordinary weather conditions might accumulate in the atmosphere to a level that would produce acute illness in a large number of people. The final health hazard under current investigation is the possibility that atmospheric exposure to lead may cause sufficient accumulation of lead in the body to increase the chance of chronic lead poisoning.

As far as has been discussed earlier, the role of motor fuel composition in photochemical air pollution is primarily the source of hydrocarbon vapors. It is only when these have reacted with oxides of nitrogen in the presence of sunlight that eye-irritating substances result. So there is no evidence at the present time that the hydrocarbons themselves are affecting the public health without this reaction taking place.

A fairly large series of studies have been conducted to see whether permanent eye diseases result from the eye irritation persistently associated with photochemical air pollution. No such findings have been found either in humans who have been studied or in laboratory animals that have been exposed experimentally. Therefore it seems reasonable that extremely widespread irritation of the eyes should be considered as a major

effect on health, but not necessarily a factor in long-term disease of the eyes. The eye-irritating effect is one principal basis for the Department's air quality standards for "oxidant index" that would be established and for the motor vehicle emission standards on hydrocarbons.

Motor vehicle exhausts contain small amounts of several compounds which in larger concentrations can produce experimental cancer in animals. It is now recognized that the level of most of these compounds in California metropolitan areas, in general, is less than the levels of the same substances in communities whose atmosphere is polluted by coal smoke. This, of course, does not mean that the levels in Los Angeles are without effect.

Thus, while substances such as benzopyreme can be detected in motor vehicle exhaust and in the atmosphere and the amounts are small, it has not been found that the composition of fuel has any effect on the amount of this substance in the motor vehicle exhausts. However, it has recently been shown that a class of substances somewhat more abundant than benzopyrene in motor vehicle exhaust is capable of causing cancer when injected experimentally into animals. Large amounts of these substances are required to produce cancer however.

Since lung cancer is more frequent in cities than in rural areas, throughout the country, studies have been undertaken to see whether persons exposed to motor vehicle exhaust have higher rates of cancer than those not exposed. No difference has been found.

On the other hand, it is clear that the time required from exposure to possible cancer producing substances to the

development of cancer is fairly long, perhaps as long as 30 years. For this reason, the possibility of the production of cancer from motor fuel exhaust must not be dismissed. As the level of hydrocarbons emitted by motor vehicles is reduced by the motor vehicle exhaust control program, it is generally assumed that there also will be a decrease in the amount of potentially carcinogenic substances.

Two other substances of substantial importance to public health are found in motor vehicle exhaust. They are carbon monoxide and nitrogen oxides. As has been discussed, the amount of carbon monoxide and nitrogen oxides present are determined more by engine operating conditions than the composition of the fuel. Carbon monoxide represents an asphyxiant. The Department has established ambient air quality and motor vehicle exhaust standards for this substance. Nitrogen dioxide when present in sufficient high concentration is capable of producing effects on health. A major effort of the Department is being devoted to assemblying the facts needed to set nitrogen oxide standards.

Concern has been expressed over the possibility that additives and, in particular, lead produce a health hazard. At present lead is considered a potential rather than a proven health hazard. So far no individual has been found with a lead level from community air pollution that is in the range in which chronic toxicity is likely to occur.

It has been established that in heavily traveled areas there is a relationship between the atmospheric levels of lead and carbon monoxide and the number of vehicles in use. It has also been shown that the lead may be emitted in a wide range of

particle size. This is important since large particles when inhaled are likely to be trapped in the defense mechanism in the lung which consists of a layer of mucus constantly being moved toward the back of the throat. Such particles are, therefore, swallowed and of these only a small fraction, perhaps 1/20th, is likely to be absorbed by the body. On the other hand, if the particles are small enough, generally less than a micron in size, they may be deposited in the deeper portions of the lung which lacks this protective mechanism. Thus a fairly large portion of the smaller particles when inhaled may be absorbed - the amount may be in this case as high as 50%. Most measurements available on lead in the air do not describe whether the particles are large or small. Obviously the effect on human health depends substantially on this attribute.

Following the recommendations of the advisory committee on tetraethyl lead to the Public Health Service, a series of studies have been undertaken by the California State Department of Public Health, the U. S. Public Health Service and others to determine lead levels in the atmosphere and in the blood and urine of persons in a variety of exposures. Preliminary studies show that the average blood lead level in Los Angeles residents are no higher than those in other communities as shown in the following table: This table lists the mean blood level in miligrams per 100 grams of blood in Los Angeles, Oakland and Alpine County and the number of observations. It shows that Los Angeles and Oakland are about the same. There is really not any difference in the two values. Alpine County, which is a rural area, is somewhat lower. These values are also comparable

to those obtained in other parts of the United States.

A more extensive study is being carried out in Cincinnati, Los Angeles, and in Philadelphia. One goal of the studies is to detect groups in the population which have the greatest risk of harm from air pollution exposure. Population studies include those with a variety of community exposure as in Pasadena and Culver City, as well as a group of traffic policemen in Los Angeles with an occupational exposure to motor vehicle exhaust. The attempt is made to select the group of individuals who would have least exposure to atmospheric pollution in the basin here to those who might have the most exposure, the most exposure being groups such as policemen in the downtown area of Los Angeles.

It is generally accepted that risk of toxicity begins to be appreciable when the blood level reaches about 0.75 mg. of lead. Such a level has not so far been observed to result from community air pollution exposures.

Data from the Los Angeles area are still being analyzed in the Department's laboratory and the results will be made available when our analyses are complete. Again some of the preliminary findings here in this latter study are not much different than the ones that are shown up here in the table. A review of the data obtained in Philadelphia study suggests that there is an increase average body burden associated with atmospheric exposure. That is, there would be slightly higher values, somewhat higher values for those people who have a higher lead level exposure from atmospheric lead.

No data are published on atmospheric levels of tetramethyl lead and hence it is difficult to assess the possible effect

of this new additive.

It is hoped that current work on lead may permit the establishment of scientifically valid ambient air standards for lead. This is one of the goals of the Department in undertaking the study jointly with the other people to obtain enough data that would permit it to do this.

Standards governing the composition of motor fuel and the use of additives are, of course, possible. Actions such as the voluntary agreement to limit tetraethyl lead to 4 ML per gallon of gasoline, specifications of quality of diesel fuel by operators of these vehicles, and Rule 62 of the Los Angeles County Air Pollution Control District already have the effect of defining fuel composition and limiting the amount of additive to be used.

Standards would be most effective for additives and specific compounds that have known effects, as it relates an effect in the community to the compound in the fuel or as emitted. With the information that is now available, it would not be possible to write standards for fuel composition which would prevent the formation of "smog".

Legislation has been enacted giving the State Department of Public Health responsibility for adopting standards on air quality and motor vehicle exhaust emissions. The Department has established such standards on several compounds to require the control of motor vehicle emission. The air quality stand for "oxidant index" has led to a motor vehicle standard for hydrocarbons emitted from the tailpipe and from the crankcase vent. These standards are for large classes of compounds, namely

hydrocarbons. It is the Department's goal to set standards for specific compounds as soon as adequate data become available. Similarly, standards have been set for carbon monoxide in the ambient air and exhaust of the vehicle. As has been indicated, work is progressing on lead standards for air quality and, if then indicated, for motor vehicles. Emission standards for motor vehicles can have the effect of regulating fuel composition. For example, the motor vehicle emission standards on lead and sulfur would limit the quantity of these substances in fuel or require their removal from the exhaust if the standards were exceeded.

In the State's program to reduce air pollution first priority goes to reduction of the emission for pollutants from the crankcase and tailpipe. In our opinion, alterations in fuel composition would be less effective. Additional consideration should also be given to increasing the efficiency of primary fuel energy use, redesign of the engine and effective urban mass rapid transit facilities. Thank you.

CHAIRMAN THELIN: Thank you, Mr. Maga. Did I understand you to say that there had been no surveys yet as to the amount of tetramethyl vapors that may be present in the atmosphere?

MR. MAGA: We do not have the data. It is my understanding that the companies that furnish this compound have made some measurements of the atmosphere of this compound.

CHAIRMAN THELIN: Your Department has not done so?

MR. MAGA: We have not done so.

CHAIRMAN THELIN: But in regard to tetraethyl - -

MR. MAGA: The study that has been undertaken by the Department measures total lead as collected on filter paper and

this would include both the tetramethyl lead and the tetraethyl lead discharged from the tailpipe which is in its inorganic form and you couldn't separate out one or the other and so you would be collecting the total lead in the study that the Department has. The organic lead that you refer to, comes form the losses in evaporation of fuel and the lead that would be contained in blow-by. This would be organic lead and would be in the atmosphere as organic rather than inorganic lead.

CHAIRMAN THELIN: Is there any way to measure this?

MR. MAGA: Yes. I don't know the details of the measurements but it is my understanding that the problem of measurement here is largely one of the sensitivity of the measurement and the amount of organic lead in the atmosphere. The methods that are available are for tetramethyl lead aren't sensitive to the point where you can accurately measure the concentrations present. This is a combination not only of the sensitive method, of course, but the fact that very low quantities of lead are present in its organic form in the atmosphere.

CHAIRMAN THELIN: Then you'd say the organic lead isn't nearly as great a factor then as the inorganic.

MR. MAGA: There is more inorganic lead present in the atmosphere than organic, this is because inorganic lead is discharged from the tailpipe and this is the major emission of lead, so that the amount of lead in the atmosphere is higher in the inorganic form than the organic.

CHAIRMAN THELIN: Are there any questions from members of the committee?

ASSEMBLYMAN RUMFORD: I'd like to ask Mr. Maga something.

Mr. Maga, you state that your greatest concern over additives has been the lead in gasoline. Why is this of so great concern?

MR. MAGA: Well, lead is a toxic substance and is known to accumulate in the body of people and produce effects. This is one of the major reasons. I think the fact that - there are several reasons, the fact that lead levels are - can be measured in the atmosphere; that Los Angeles, the major center of population in California, has some of the highest if not the highest lead levels of any place in the United States; that the increase in use of fuel in motor vehicles will lead to the conclusion that lead levels will increase with motor vehicle use; and that lead is a toxic substance. A combination of these, of course, leads to concern and as I tried to point out at the present time is viewed by the Department as a potential hazard, it is not a proven hazard, but certainly something that the Department should be concerned with studying. One of our major interests here is trying to define what is a level in the atmosphere that is of public health concern so that there can be assurance that this isn't the health hazard if such is the case, as well as if it is a health hazard of writing standards of emissions of lead to regulate this.

ASSEMBLYMAN RUMFORD: Would then you say that the lead level that is generally absorbed by the resident of Los Angeles due to different sources is not of itself at this time a dangerous situation?

MR. MAGA: The Department has no information to indicate that the lead being inhaled by the people of Los Angeles has -

ASSEMBLYMAN RUMFORD: It has no record of anybody having

succumbed to lead poisoning in this particular area.

MR. MAGA: From atmospheric lead, that's correct in the community.

ASSEMBLYMAN RUMFORD: Now, from other studies of the Federal government, perhaps private agencies, has there been any indication either here or the United States that the lead in gasoline has caused serious injury to the lungs or other organic -

MR. MAGA: I assume that you are referring to lead in the gasoline which results in increased atmospheric levels of lead. There have been health problems associated with the handling of lead in close places, but we are talking about air pollution.

ASSEMBLYMAN RUMFORD: We are talking about sources from the exhausts and other methods of escape.

MR. MAGA: To the best of my knowledge this is correct. There is no evidence to show this. The levels have been measured in other places in the United States that were reported in Figure 4 indicate that some places are about like Los Angeles. The levels in the blood of people that were reported in that table on page 11, the values for Los Angeles and Oakland seem to be quite similar to values for other parts of the nation and there is no evidence that these concentrations - atmospheric concentrations in other parts of the nation have produced them.

ASSEMBLYMAN RUMFORD: Is there a possibility that the organ might become a source of cumulative lead over a period of time?

MR. MAGA: I'll answer this with reservations. This is true, lead does accumulate in the body. It accumulates from all sources, food, water -

ASSEMBLYMAN RUMFORD: What organ would it attack?

MR. MAGA: Let's say it would act somewhat similar to calcium, I believe. It would accumulate in the bones, perhaps if you want to go into more detail here, I'll get Dr. Goldsmith.

ASSEMBLYMAN RUMFORD: Well, we'll probably get Dr. Goldsmith later, but I just wondered if you'll answer from this point of view.

MR. MAGA: Well, I think he'd better answer this one.

CHAIRMAN THELIN: Dr. Goldsmith, would you state your name and your position for the record.

DR. GOLDSMITH: I am Dr. John Goldsmith. I am in charge of studies on the health effects of air pollution for the California State Health Department.

CHAIRMAN THELIN: Fine. Could you answer this question that has been posed by Mr. Rumford, or would you like him to repeat it?

DR. GOLDSMITH: As I recall the question, it was where does lead accumulate in the body.

ASSEMBLYMAN RUMFORD: That was one, and if it was cumulative in the body, and if so, where does it accumulate? In what particular organ?

DR. GOLDSMITH: Lead accumulates primarily, as Mr. Maga indicated, in the same manner that calcium does, and for this reason a great deal of lead which is absorbed by the body is stored in bone. In addition, lead like virtually every other substance to which the body has been exposed accumulates in other organs to smaller extent. This includes the liver, the lungs, brain and so forth. Our Department is supporting studies

to determine the amount of lead in the various organs of the body of people who live in this area. This is a fairly difficult type of research but fortunately there are good resources to carry this out technically. There is very little of this type of information that has been published. It is not altogether certain what levels are normal or to be expected. So far there is no evidence that the data which is available indicates that the people in Los Angeles differ very greatly from those in other parts of the country.

ASSEMBLYMAN RUMFORD: That is as far as the lead is concerned on the experiments that have been conducted?

DR. GOLDSMITH: That's right. These are studies and not literally experiments. These are human -

ASSEMBLYMAN RUMFORD: We have been relying upon - it states here - we have been relying upon Federal information by and large prior to our own experimentation? As to the results of the extensive exposure to -

DR. GOLDSMITH: Well, there's a cordial teamwork between the Federal program and our own. As a matter of fact, I think it is necessary to state that the work which might have helped to evaluate the role of lead additives in air pollution really had not been done, the work which was suggested by the original ad hoc committee of the Public Health Service in 1925 concerning the background levels, the levels in persons who might be exposed, the data for estimating the possible health effects of lead additives had been done quite skillfully, quite easily for persons with occupational exposures, but very little had been done with respect to obtaining the kind of data that is now

being done jointly by the Public Health Service in several other cities and partial assistance from the Public Health Service by our Department in California.

ASSEMBLYMAN RUMFORD: I see. AB 2335 - Mr. Brown, wasn't that your bill? - specifically attempts to eliminate, if I remember correctly, the use of lead tetraethyl in gasoline. Based upon the premise that this was the poisonous element in the compositional gasoline and as a result of that people were affected either from their bronchial or other organs of the body and this hearing primarily is to allow the testimony, scientific and otherwise, of the people interested to bring forth the question and develop a premise whether lead tetraethyl is actually, as far as we know by scientific information, actually affecting people to a degree that we should take specific action and pass AB 2335 or some like measure, is it your thinking as a technician guarding the health and welfare of the state, in this instance, that there is no need for this type of legislation as far as public health is concerned?

DR. GOLDSMITH: That's a tough question, Mr. Rumford. I think it involves more than technical issues, but I'll be glad to -

ASSEMBLYMAN RUMFORD: Well, we want your scientific explanation.

DR. GOLDSMITH: I think that the existing legislation directing State Health Department to establish standards of air quality provides a framework within which scientific judgment can be brought to bear concerning the possibility that a given level of lead in the atmosphere produces a given risk to health

and hence levels should be kept below this. Additional legislation setting motor vehicle exhaust standards, which would be based on air quality standards would then have the effect, if this process were continued to include standards for motor vehicle emissions, of limiting the amount of lead which was to be added to gasoline. I have one concern here and that is that it is possible to stipulate in legislation that no amount of some substance be permitted - now, actually, this is quite a logical position from one point of view, but since there are so many sources of atmospheric lead and since, in many cases, amounts of such substances that may be present and may produce no detectable effect or no effect on extrapolation, it seems to me that what one would prefer in legislation is to say that no amount which is harmful should be present and I think this would be an amplification. I don't recall the particular piece of legislation, but from a technical point of view, I believe that this permits the most suitable use of scientific resources and I would encourage the use of phraseology of that sort. Does this answer the question that -

ASSEMBLYMAN RUMFORD: Yes. I think you have done very well. Mr. Maga, I'd like to return to this. You mentioned over a long period of time there is a possibility that one could develop a carcinogenic reaction. Now how did you arrive at such a conclusion?

MR. MAGA: Well, I think this is really in the area of Dr. Goldsmith.

ASSEMBLYMAN RUMFORD: Well, your statement now, you may want to -

MR. MAGA: That's right. This is a known characteristic

lung cancer and cancer in general that is a long time exposure. It isn't a one exposure. It is not one exposure to a substance with no repeated exposure.

ASSEMBLYMAN RUMFORD: You say that this is a known fact -

MR. MAGA: That is to my knowledge.

ASSEMBLYMAN RUMFORD: This is a known fact that a lung exposed to lead over a long period of time will cause cancer?

MR. MAGA: Oh, no. Not lead. Lead has not been incriminated as a cancer producing -

ASSEMBLYMAN RUMFORD: Well this is the point that we are talking about. Are you talking about benzopyrene?

MR. MAGA: Yes, a group of compounds that -

ASSEMBLYMAN RUMFORD: A group of irritants or what?

MR. MAGA: They are a group of hydrocarbons in this case related to motor vehicles that have the characteristics of the tarry substances in fuels and in exhausts.

ASSEMBLYMAN RUMFORD: Specifically, what have we got to say about lead?

MR. MAGA: Lead is not known to produce cancer of the lung.

ASSEMBLYMAN RUMFORD: Even over a long period of time?

MR. MAGA: To the best of my knowledge.

ASSEMBLYMAN RUMFORD: I see. Do you join in that Doctor?

DR. GOLDSMITH: I think that is substantially correct.

ASSEMBLYMAN RUMFORD: One more question. We speak of 3 cc of lead tetraethyl I think in one gallon?

MR. MAGA: Yes sir.

ASSEMBLYMAN RUMFORD: And an area where the atmospheric conditions in Los Angeles is one in which you have a depressed

condition and, of course, this crucible which produces this "smog" condition, is there any possibility that you would get concentration of the lead content?

MR. MAGA: Yes, I think you would conclude that in a place like Los Angeles or an area with limited dilution of wind movement, the atmospheric levels as well as other pollutants would be higher and this would be shown and reflected by the measurements of the atmosphere of lead and I think this is one of the explanations - this is one of the explanations of why some of the values for Los Angeles are higher. It's a combination of the large amount of lead emitted in the atmosphere as well as the more limited dilution available.

ASSEMBLYMAN RUMFORD: We haven't touched on the carbon monoxide or the hydrogen either, we have been concerned with lead at this point. Would this also hold true for these other irritants found in air pollution?

MR. MAGA: I think this is a general rule that would hold true that the concentration of others would take place. In fact there have been some studies made on your freeways of the amount of traffic and the level of carbon monoxide and atmospheric lead. These are correlated and as traffic count has gone up, the carbon monoxide values have gone up and so has the lead levels gone up and in sampling their freeways as contrasted to out in the communities, the values that you get for atmospheric lead are higher near the freeways, somewhat higher than you would find out in the communities. So that these would go together.

ASSEMBLYMAN RUMFORD: I see. Doctor, you had some comment?

DR. GOLDSMITH: Yes, Mr. Rumford. I think it is not made entirely clear from our written presentation that concern about lead should be based upon the atmospheric levels averaged over substantial periods of time. Perhaps weeks or say four weeks and to consider lead in the same category as other irritants, irritants also present perhaps or at least greatly influenced by motor vehicle exhausts, is perhaps not necessary from the medical point of view. Whereas the acute increase in irritating substances by a prolonged weather inversion may be a very serious matter, such a condition might have relatively less importance from a health point of view with respect to lead because the body in effect averages its exposure over fairly long periods of time and it is not an irritant as such.

ASSEMBLYMAN RUMFORD: Mr. Chairman, with your permission, may I expand my question just a little here?

CHAIRMAN THELIN: You certainly may, Mr. Rumford.

ASSEMBLYMAN RUMFORD: Mr. Maga, as Chief of the Division of Air Sanitation, what is your comment at this point about the air condition in this basin presently compared to, say, five years ago?

MR. MAGA: Well, in review of the maximum levels of air pollution in the past few years there has not been an increase in the concentration of - the maximum concentration of several pollutants such as oxident over a period of a few years. Now, this is rather a variable thing. It depends on the meteorological conditions that you mentioned and has been discussed before. It also is related to the controls that have been going on during this period of thick sources of air pollution

by the District, so that in the Los Angeles - downtown Los Angeles area for instance, there has not been a continuous increase in the levels where each year you could look at higher concentrations. However, there has been, and this is somewhat related to additional measurements in the area, a widening out or spreading out of the levels, so that areas which were not affected with this high value, such as Riverside, San Bernardino and the San Fernando Valley, are now having higher exposures, more frequent and higher levels of air pollution. This is probably a result of the growth in the fringe areas, the expanding out from the center of the population spreading people in cars throughout the area. It still is quite high. Quite high levels of air pollution are experienced, severe eye-irritation, of course, on frequent intervals. But you can't take a curve and plot each year an increasing higher level of oxident, for instance, in the downtown area of Los Angeles.

ASSEMBLYMAN RUMFORD: That's all I have, Mr. Chairman.

CHAIRMAN THELIN: Any other questions. Mr. Brown?

ASSEMBLYMAN GEORGE BROWN: Mr. Maga, I want to ask you a few questions on this lead matter if I may. Your Table 4 on atmospheric lead does show that Los Angeles has the highest average concentration of any of the cities tested, is that right?

MR. MAGA: That's correct.

ASSEMBLYMAN BROWN: Now, looking at Page 11, you state that when the lead concentration in the blood reaches 0.75 milligrams of lead per hundred grams, that this is a level where there is some danger of poisoning, is that right? In the table which you have at the top of Page 11, you compare Los Angeles, Oakland, and Alpine County and the means for Los Angeles and Oakland, which

I presume have somewhat similar conditions, are more than 50% higher than Alpine County. Is it your contention that this isn't statistically significant or that it is statistically significant?

MR. MAGA: I might point out two things. One is that some studies on atmospheric concentrations of lead have indicated that Philadelphia has values that are as high as Los Angeles. I think I referred in my presentation to - - that there really wasn't much difference in values, I meant between Los Angeles and Oakland. I didn't mean this to include Alpine County. I would think if you have a large enough sample of people that the difference between 0.11 and 0.2 would be significant. I haven't analyzed the data to determine its significance, but with sufficient number of samples such a value, of course, would be significant.

ASSEMBLYMAN BROWN: In other words, if this was a large enough sample then that 50% variation would be significant? Looking at the ranges, you point out that in Los Angeles and Oakland the average maximum is roughly about 0.5 or something of that sort. In other words, the maximums are 2/3 of the level which would produce danger of health hazards, is that correct?

MR. MAGA: Are you comparing Table 4, now?

ASSEMBLYMAN BROWN: I'm looking at Table 4 which shows a range from - -

MR. MAGA: Perhaps Dr. Goldsmith might be able to answer your question.

ASSEMBLYMAN BROWN: Well, I'm just talking about arithmetic, Doctor.

MR. MAGA: I'm sorry. I didn't follow the - -

ASSEMBLYMAN BROWN: I say that the average maximums are approximately .05 and that your level in which it becomes hazardous is .075, so that we have reached the point about 2/3 of where it could be. Now, lead is an accumulative poison, is it not?

MR. MAGA: That's correct.

ASSEMBLYMAN BROWN: It continues to accumulate. We can presume that these maximums are due then to the accumulative effect of the "smog" condition over in Los Angeles, let's say, the last 10 or 15 years, which have been serious. Is that right?

MR. MAGA: There are several things here. As Dr. Goldsmith has pointed out, it is the average lead exposure over a long period of time that is important. It is the accumulation of lead in the body of the person that determines its effect, more so than the maximum concentration in the atmosphere. And the accumulation in the body of a person is related to the long-term exposure, the average over a long period of time. So it would be more meaningful to look at the average lead levels rather than the maximum lead levels.

ASSEMBLYMAN BROWN: Well, why would it be more meaningful? Didn't some of the people that you sampled in Los Angeles and Oakland have lead contents that ran as high as .047 and .057?

MR. MAGA: That's correct. But lead - atmospheric lead is not the only source of lead.

ASSEMBLYMAN BROWN: Well, let's just assume that these people travel the freeways every day, where they are exposed to the lead continuously and some of the others don't travel the

freeways every day.

MR. MAGA: Well I think the study that the Department is undertaking in Los Angeles on various groups of people is attempting to do this. To separate out classes, know their exposure, relate this thing to their commuting and to their place of residence.

ASSEMBLYMAN BROWN: This sample is not devoted entirely to people who travel the freeways or don't travel the freeways, I presume.

MR. MAGA: No, this is a sample of persons who were available. It was a preliminary study. It is indicated here.

ASSEMBLYMAN BROWN: I am just pursuing some hypotheses. We'll assume that those who showed the maximum concentrations, which is in the vicinity of 2/3 of the permissible level had traveled the freeways and had substantially greater exposure to the "smog" situation than those who showed the minimum exposure. I presume this is a reasonable hypothesis and that this accumulation to the point of 2/3 of the toxic level had developed over a period of - oh, it couldn't have been more than 10 or 15 years because we haven't had that serious "smog" condition in Los Angeles for more than that long. Now I'm just projecting. If that is the situation, in another 10 or 15 years the accumulative effect of that lead will bring those who are now at the .05 level up to the .075 level.

MR. MAGA: I think that there are a number of assumptions here. One is that some of these people in the .05 level, let's say, may have had an industrial exposure to lead. Most of the lead could have come from this source for instance.

ASSEMBLYMAN BROWN: Well, I think that the assumption

that at a random sample the high levels were produced by industrial exposure as compared with the assumption that it was produced by exposure on the freeways, the latter assumption is the more reasonable, because the number of people who work with lead in our society is small.

MR. MAGA: I think I'll let Dr. Goldsmith expand this, but I think that not all the lead in a person comes from the atmosphere and this must be taken into account too.

ASSEMBLYMAN BROWN: Would you like to comment here?

DR. GOLDSMITH: Yes, Mr. Brown. A number of things that you are presuming are under current study. It is unfortunately not possible with our resources to obtain laboratory analysis of all of the specimens so far collected. There are multiple sources of exposure in any community and it is our task and responsibility by the direction of the Legislature to assess how much of the exposure to community air pollution might be responsible for these differences. We have made efforts in collecting the additional data to which Mr. Maga referred to classify the individual as to their use of freeways, how much time per day and at what hours of the day and traffic patterns in order to try and answer the questions that you, I think very correctly, put to us.

ASSEMBLYMAN BROWN: Your presentation, Doctor, is very commendable. I think you have taken a dispassionate and analytical approach and I will confess that my questions are intended purely to present the worst side of this picture. But looking at it from that point of view, I say, and I am asking if you can deny it based on these statistics, that in 10 or 15 years it is possible that you will have a substantial number of people who

have exceeded the permissible level of lead in the body which you indicate and that they are going to start dying from that.

DR. GOLDSMITH: Well, I think that what would be necessary to answer this very serious question, one seriousness of which we are also concerned with, would be to study the same group of persons over a period of time. Now, there have been such studies of persons who have industrial exposures and, for example, in comparing the exposure to community air pollution and industrial exposure we find the community air pollution levels are very much lower than those which are permitted industrial workers. However, the industrial worker's exposure is for defined periods of time, eight hours a day, and for his lifetime. Just by way of making this comparison, let me say that there are two major numbers used for industrial exposures, these are 150 and 200 micrograms per cubic meter for an eight-hour day. Now the community air pollution levels that we observe in Los Angeles, even taking some of the high values as representing averages are of the order of magnitude of 9 or 10 micrograms, but these are averaged over a 24-hour period. We do not know whether the body can cope with this small, but rather more continuous exposure in contrast to the intermittent exposure that the industrial workman has. On the other hand, there is evidence that the exposure which industrial workmen have, valued below the levels I have cited, are not necessarily associated with an indefinite increase in the amount of lead which is contained in the body and I think that we need not assume that there is an indefinite increase from community air pollution exposure either. What we do need to do is to find out exactly how much there is and this, I think, is something which is underway and I hope we'll

be able to report. I happen to have received this morning an additional segment of our study in Los Angeles, to which Mr. Maga has referred and the mean values and the extreme values are essentially those as are shown in the table. I merely want to add this bit of data. This was a group of persons studied in Culver City. In all of the studies that have been so far reported in the current series we have been able to detect differences between men and women in the averages, between cigarette smokers and non-cigarette smokers in the averages, and between rural residents and urban residents. The differences, however, that we observe in every case are of modest magnitude.

ASSEMBLYMAN BROWN: Well, I am merely basing my extrapolations on the figures that you have given and I am doing this on the basis that according to your statement, lead is considered a potential but not a proven health hazard and apparently the reason it is not proven is that you haven't accumulated enough data. But if you extrapolate the data that you have, a reasonable assumption is that some people are going to start dying in the not too far distant future.

DR. GOLDSMITH: I don't believe I would consider that this data supports this kind of extrapolation.

ASSEMBLYMAN BROWN: You don't consider that the data does, are you going to be able to have data in the reasonably near future which you could justify some extrapolations from?

DR. GOLDSMITH: I think we will be a lot better off in this regard. We are studying people and getting data on how long they have lived in the Los Angeles Basin and we are collecting

data not only from Culver City, but Pasadena and from motorcycle policemen who have very heavy exposure and we also have data as to how long they are exposed.

ASSEMBLYMAN BROWN: How long do you think it will be before you have reliable data on which you can extrapolate?

DR. GOLDSMITH: I think the present series of studies should be completed and the data available for reporting within a year.

ASSEMBLYMAN BROWN: Thank you.

MR. MAGA: One more comment I might make. If you extrapplate the data on the .057, for instance, as you did, this will be a valid argument that indeed this would be a hazard in years, if the assumption is made that the .057 has been obtained from breathing lead from the atmosphere. If all this or most of it is obtained from the atmosphere, then this would be -

ASSEMBLYMAN BROWN: Mr. Maga, we seem to be leaving the impression here that industry and gasoline is the source of all this lead. There are a great many other sources, are there not?

MR. MAGA: From the standpoint of the accumulation in the body of man, yes. Food, water are important sources.

ASSEMBLYMAN BROWN: We are talking about a health hazard, that's what we are talking about, this accumulation of lead -

MR. MAGA: The total lead from all sources added up. Air pollution, food, water. There is some indication that smoking is a factor here.

ASSEMBLYMAN BROWN: Cigars?

CHAIRMAN THELIN: Do you have any evidence that or have you made a survey so that you would know if our gasoline or fuel

in California have more additives than it has elsewhere?

DR. GOLDSMITH: I can't answer that. We don't have the data on which to make this judgment.

CHAIRMAN THELIN: Very well. Are there any other questions from members of the committee? If not, we thank you very much for your testimony, gentlemen, and we will let you go now unless there is something you care to add at this time.

DR. GOLDSMITH: No, I think that concludes our testimony. Thank you, Mr. Chairman.

CHAIRMAN THELIN: Thank you very much. In our next group of witnesses we are going to have several representatives of the Citizens' Anti-Smog Committee. I will call first Mr. Chandler Phillips. Mr. Phillips would you come forward, please? Can the members of the committee see this chart that Mr. Phillips is trying to put up? I think that's all right, Mr. Phillips.

MR. PHILLIPS: My name is Chandler Phillips. I am a Consulting Mechanical Engineer. I live in Glendale, California. I worked 18 years with the petroleum industry and I handled all the changes that took place in the paper work and the reports to the government for the changes in the refinery at the Wilmington and Dominguez refinery during World War II. I worked five years with the Federal government as a special investigator for fraud cases. My work was related in tying the accounting records into the mechanical processes involved to determine if fraud had been committed.

I'd like to point out now before I go into my presentation after listening to the testimony from the State Public Health Department that Public Health Bulletin of the Federal Government,

No. 163, was a study of the relation of tetraethyl lead to public health. And the tetraethyl vapors or gases are not caught on filters as such. They are only absorbed on activated carbon which is the most sensitive method and was used in evaluating the gases in the air. All the reports that have been furnished to me or I have been able to find show that no public health official has made a comprehensive study of the tetraethyl or methyl vapors in air as compared to the particulate or particle lead. This is very important because these vapors are many times more toxic than particulate matter. As a matter of fact, one drop of tetraethyl lead on the impact skin can be absorbed and cause lead poisoning.

The large standards allowed by industry in the manufacture of tetraethyl lead was established by the Public Health Department after a very serious accident in the manufacture of this product. This occurred by leakings in pipelines and the people were unable to detect the odor. One of the co-inventors of the tetraethyl lead, not knowing its danger, went violently insane and hung himself. There were several deaths that occurred from this particular vapor in industry. They changed the process of transferring all fluids and this is the way it is now handled in the refinery, under vacuum. So if a line springs a leak, they suck air in. So saying that 200 micrograms is a safe limit for industry, workers are not exposed to these levels. Even then these levels are set by industrial doctors and most of them get their business from the industries. Now, the public tests have not been made at breathing level and I call your attention to this fact or ask this question. We burn approximately 7,000,000 gallons of gasoline here daily. One gallon of gasoline produces about 1,000 cubic

feet of exhaust gas, so this becomes seven billion cubic feet of exhaust gas. More than this is expelled in the refinery, but this particular seven billion, is it more dangerous 200 feet in the air at a refinery or at two feet above the ground? Results have shown that this has to rise but a short distance and it has to be diluted. You know you can't live in these vapors. The reason we are not killed from carbon monoxide, let's face it, it is lighter than air and rises. The California State has studied the effects of carbon monoxide. There was a study in Public Health Bulletin 278 of carbon monoxide for 13 years for the men in the Holland Tunnel. Although no ill effects were found from this exposure to carbon monoxide, the researchers could not explain the high lead excretion level of these officers and this lead excretion was the same whether or not they worked in the tunnel or worked on the streets. Now after this accident in about 1926 or back in that time, they checked the blood level in lead, as you were talking about. At that time it was set very low. This has been continuously raised and if this keeps on they find more level in blood and people don't die from lead poisoning, then they'll say it is safer to have more lead in your blood. It's been raised five times since that time, as a matter of fact.

Now there is another very important thing here. Tetraethyl lead fumes are taken by the blood to the brain as a hydrocarbon, thinking it's a brain food. The lead that is actually stored in the bones is a safety valve to protect the body system, but this can degenerate the bone marrow and these protect the parts of the body. Our commitments to our mental institutions have risen in a direct proportion to the use of tetraethyl

lead in industry, particularly in motor fuels. One-third of a billion pounds a year are now being manufactured and sprayed out on the general public in the interest of improving fuel. Tetra-ethyl lead does not improve a fuel. It is put in the fuel as an anti-knock and it achieves this anti-knock value by slowing down the rate of combustion of the fuel. You hear it being said that olefins are bad, but the standard for measuring a fuel is a combination of an olefin with a saturated hydrocarbon of sulfuric acid treatment process and this is known as iso-octane and has an octane rating set at 100. Now I started my experiments, and released them to the public in 1955, as a result of my investigation of the changes of the composition of gasoline that took place during World War II. This particular chart here shows you -

CHAIRMAN THELIN: Mr. Phillips, do you want to use a pointer so you won't have to leave your mike?

MR. PHILLIPS: Thank you. This shows the changes that took place in gasoline before World War II during the peak war-time condition, after the war and up to 1955. These are Bureau of Mines reports. Now this statement in here was not made without some forethought and it appears in an advertisement of the Life Magazine of October 18, 1954.

CHAIRMAN THELIN: Do you want to move that mike over a little, Mr. Phillips, so we can catch your voice.

MR. PHILLIPS: This says, dirty burning tail ends produce more than a teacup full in every gallon removed from a gasoline. This shows a clean burning gasoline compared with a dirty burning gasoline. Now this amounts to a terrific amount of impurities put into the air, but to make this gasoline operate in your car

without knock, the tetraethyl lead content expelled into the air from 1941 to 1954 from automobiles has increased ten-fold. This is increase in quantity and increase in growth.

This is the point that I am pointing out in the relative changes in gasoline. And we see the change here. Remember the heavier this gasoline, the higher the boiling point. This is like adding sugar to water. It boils at a higher temperature. So more heavy ends are in this fuel, this is the final boiling point. The cleaner the fuel, the lower this is. This is premium gasolines from Southern California in the summertime and this is premium gasolines in the winter. You see the same reports. This is the heaviest fuels, this is the lightest fuels. We see the same picture in the regular gasolines. Both summer and winter. We are getting now a gasoline that is heavier than our peak wartime condition. It was patriotic to burn it then; it is not today, gentlemen, it's deadly. Our lung cancer has increased at alarming rates. We have twice as many tooth cavities in our children as any other area. We have a limited air supply. Why should we release known poisons into the air and have to breathe them? Without proper study, they would release a new poison methyl. Tetramethyl lead. This is even more volatile than ethyl lead and without any - absorbing any tests of this in the air, they conclude because it does not kill rats, it kills rats not quite as quickly as tetraethyl lead, it is safe to release to the public.

My experiments have been proven, and I released them to the public in 1954. I took on my automobile a device to analyze the vapors that were being put out and this took two forms. I

equipped my motor to run on either butane or propane, a clean burning fuel, and then I could turn on a sample of gasoline I wished to test. The chamber I had on the back of my car was approximately four feet long. It had a light beam that went between two prisms and went into a photoelectric cell. I could adjust the intensity of the light source and I would in burning a clean fuel set up the intensity of the light source so my photoelectric cell read 100 on my reference fuel. I would then turn on the electric pump and pump in gasoline and keep the motor at the same speed. These other fuels burned dirtier. I took that same gasoline and treated it by the refining method known as the 98% sulfuric acid treatment and it removed these impurities and the fuel when retested, burned clean and reduced light by the cleanliness was five or six times. I took the vapors out and passed them through a large plastic bag and irradiated them to see the photochemical reaction that would take place on the two fuels. The cleaned up gasoline produced very much less. I brought this up before the Air Pollution Control District and they performed part of my experiments. They checked the photochemical reaction of a cleaner fuel with one with a higher content. They reported that they could reduce air pollution two-thirds in the aerosols by this method. They also had the Bureau of Mines testing station at Bartleville, Oklahoma perform the test on the other half and using a regular motor gasoline compared the iso-octane, they reported a sevenfold reduction in air pollution by cleaning up the fuel. I claim that if iso-octane was available today for all the cars and the lead was eliminated from the air, we would have a substantial reduction

in our air pollution problem.

Let's get back to Public Health Bulletin 253. This is a very interesting bulletin because it is the relation of the toxicity of lead and its common compounds. They took guinea pigs and they let the guinea pigs breathe, they calculated out the theoretical amount of air that they could inhale, then they let the guinea pigs breathe everything from lead arsenic in the air, metallic lead - here's the different lead compounds - and this is the amount of lead retained in the lungs of those guinea pigs from that report. Now the average lead that was expelled out of the automobile exhausts with particulate matter, and they ranged in the experimental animals, only about six to eight percent was retained in those guinea pig's lungs. When they let them breathe lead phosphate, 47.4% was retained in the guinea pig's lungs. This is a sixfold increase. If they want to prove in Los Angeles today lead is dangerous, analyze the lead phosphate content of the people that are dying in this area. Because this particle is one-third of a micron in size, it is so small that it lodges deep in the cells and sacs of the human's lungs, as it does in the guinea pig. And we are being continually increased in amount that this will be put into our gasolines. I have a study by the S.A.E. Journal which was to investigate the advisability to stop rumble in an engine. Either of two methods were found to be sufficient. Remove the lead from the engine fuel and it did not rumble or increase the tri-cresyl-phosphate or the phosphate content of the fuel fivefold and you also stopped the rumble. They are now putting in enough to convert about two-tenths percent - about 20% of the lead that is in the gasoline into these lead phosphate

vapors. They propose in the S.A.E. Journal to increase it so that all the lead is converted to be inhaled in our lungs in small particles. This is the cheapest method. This does not require any refinery change, just buy some more chemicals and add it to the refinery.

I have offered $1,000 to any scientist or engineer that will get on this platform and testify before you than any after-burner or any control device will destroy these lead fumes as such. It will turn up in some lead compound or another. So will the phosphorus, so will the bromine and the chlorine and all those are added in the refinery to make the lead get out of the motor. If you did not do this, it would actually foul up the engines and they couldn't run. When they started using leaded gasolines in English motors that the valve stems were not of special steel, the chemical attacks on these ruined many of these engines. But we can pump these vapors out at tailpipe level to be inhaled and we have no law that protects us. We don't even have adequate tests to evaluate these things before they are released on the public. I proposed, and it was proposed by many organizations, that the bill that you are considering gradually reduce the amount of tetraethyl lead in gasoline. This would also eliminate the tri-cresyl-phosphate and all the bromine and the chlorine and those other poisons that are all heavier than air.

It may be that it should be spread out a longer time, but the petroleum industry, by competitive ability could adjust itself to produce cleaner fuels and we could all benefit by reducing that lead content.

Let's go back to sulfur. Which is more dangerous, six

hundred tons of sulfur in the air from the top of 200 foot stacks in the refinery or 30 or 40 tons at tailpipe level?

This chart from Public Health Bulletin shows the increase in sulfur in our premium fuel from 1941 to 1954 by the petroleum industry and it is over three fold. Here is our prewar level, here is what it was after the war. Notice what happened in wartime? We can leave it in the fuel, so why not leave it in. It's cheaper than the cleaning up of gasolines and hauling of tars and slugs and gums out and dumping them in the ocean because the Fish and Game Commission doesn't like that. Now those gums and tars can be removed and the product can be sold at a profit because what the sulfuric acid treatment removes from the fuel by the prewar treatment was acidic oxygen groups, reactive hydrocarbons, and nitrogen compounds. You get a large amount of nitrogen compound. Sometimes as much as 50% in the gasoline are composed of nitrogen compounds and California fuel proves to have the highest percentage of nitrogen. By adding hydrogen in the cracking process you convert the nitrogen to ammonia. You convert the sulfur to hydrogen sulfide which can be burned to produce acid and you create the acidic oxygen groups which are converted to water. But there never has been a history of a pollutant put into the air that was voluntarily removed where it was more profitable not to do so unless it was by legislative action. And I want to refer you to two specific instances. I could go into more.

Number one. The smeltering industry in Arizona was killing the farmers' crops for 20 miles around the smelter. They went to court and the court says, "Clean up this." The smelter

says, "We'll have to go out of business. We can't do it." They cried the blues. "We are going to move out of the area. We'll go somewhere else where we can pollute the air." They didn't. They started cutting out these sulfur fumes from their exhaust stacks and they reported in the U. S. Year Book on Minerals more profit from the recovery of gold and platinum and silver going out those exhaust stacks than they did from their smeltering of the regular copper. In the South there was a particular company that was producing soap and other products and it was making such a stench around the area that the people went to court and they said, "We want to get rid of those smells. Our stomachs turn over, we can't sleep, they are absolutely nauseating, a nuisance." The court told this company to clean up things and what did the company do? They called in their chemists and said, "How do we get rid of these fumes?" They said, "Bubble them in sulfuric acid. That will destroy them." They put a big vat in and they started doing this and everything subsided. Pretty soon the fumes started to reappear and the plant manager says, "What's happening?" They said, "Well the acid has become spent. We have put in new acid." And the foreman was digging out the material that had formed in the bottom of that pit and the manager said, "What's that?" And he said, "I don't know. That's the smell that was bothering the people and it is now in this cake form." He said, "What is it made of?" And he said, "I don't know. Have our chemists analyze it." They analyzed it and it was a pharmaceutical chemical that they are now the sole producer of outside of Germany. So they went into the drug and cosmetic business. It is going to take legislation and it is going to take people with vision in your

place to enact laws that will control this. Naturally it is more profitable to make a fuel with dirty tail ends in and add sufficient amount of tetraethyl lead to silence a knock or tetra-methyl lead. I believe if long-range studies were made, and some toxicologists think that the composition of ethyl and methyl in lead bears the same relation as ethyl and methyl alcohol, they would show that these methyl fumes that are now being released from methyl lead are as dangerous to the public as diluting their drinks with methyl alcohol.

Until things are proven, we should not be guinea pigs. Neither should our children. They can't help themselves, but we are old enough that we can. And that's why I have made this appeal to you gentlemen to do something about this. I will furnish a report with all these references and they are documented. Body metabolism is not destroyed by lead in the same method by slow incipient poisoning that it is by lead in larger amounts. You get variations in the blood cells. You get variations in maybe lines around the fingernails - tell tale marks of lead poisoning. But this is quick lead poisoning. This is not the slow amount day after day that the people are subject to in this area. One gallon of gasoline with three milliliters of tetraethyl lead requires over 1/2 million cubic feet of clean air to dilute that so that it is safe to breathe. This chart shows the amount of lead being released in various areas of Los Angeles City in relation to how much air is needed to dilute these so they are safe to breathe. Now all poisons are relative and the public hygienists say,"Well it's not a poison if we give it enough air and you breathe a little enough of it." This has never been proven. But if you spread

the lead poisoning of the air out so it would not poison the people, all over 1300 square miles where most of us live down here, from 1947 to 1954 it has increased about six to eighteen feet. This is only for the first part of the morning traffic hours. If you took it inside the City of Los Angeles, the lead vapors would go from 15 feet to 50. If you took it in these five cross districts right here, which comprise the central part of this area here, the lead vapors then would read, and this is a completely divorced area of buildings, trees or hills, it would go from 45 feet in '47 by 1954 it required over 170 feet. Now our highest death rate for these ten health districts are down here with the highest density of automobile traffic. The Central District in Los Angeles. The Central Health District has the highest death rate. The lowest death rates are out by the ocean, where they can get the dilution from the ocean air.

There was a change that occurred in the Watts Health District that was correlated by a census that was made in 1953 and almost a 50% increase in death rate occurred in that district in one year. Now, how did the City of Los Angeles Health Department reduce the death rate in that district so it was comparable with surrounding districts? They increased the area to include more people that lived out by the ocean and lowered the rate and this area is the one surrounded by refineries. So even releasing something 200 feet in the air can prove dangerous to a Health District. What is something going to do released at ground level that has to be diluted? These studies should be made of people in traffic accidents but the quickest thing to prove this is the dangerous way that tetraethyl lead is converted to lead phosphate by these

phosphorus additives and that particle size lodges in the lungs and cannot be coughed up or disposed of. And you can analyze the human beings that are dying in this area to see how much lead phosphate there is in the air and there is no industry making this and pumping it out, it comes from the automobile exhausts and it seems to me this study should be of prime importance.

CHAIRMAN THELIN: Does that conclude your remarks?

MR. PHILLIPS: That will conclude my remarks and I will be happy to answer any questions directed to me if I can.

CHAIRMAN THELIN: I wonder if you would go over again the beginning of your presentation about the manner in which these tetraethyl vapors are tested. Apparently you don't feel that the tests that are being conducted are done in the proper manner. It wasn't quite clear to me what you meant by that.

MR. PHILLIPS: Yes. These vapors are not being tested in the same manner that they were with Public Health Bulletin 163. Now this is the study of the relation of tetraethyl lead to human habitants. Now they should have done this to test these vapors. There should be the total lead in the air, first the amount that is trapped on a filter paper. A glass mat filter or something can be easily analyzed, but the gas vapors go through these filter pores regardless of how small these become and you cannot protect a man from wartime gases by giving him this type of filter over his nose. You must put an activated carbon filter behind this to absorb the gases. You can analyze the carbon, the activated carbon before the analysis and after the analysis and taking a sample over a twenty-four hour exposure. When a man is on a freeway two or three hours a day under these heavy concentrations,

that is when the sample should be taken to see how much lead he is able to breathe in at that particular time. It is granted that a twenty-four hour exposure is also dangerous, but that was the method used in this Public Health Bulletin to make the analysis then. And by the way, after this accident that happened in the manufacture of tetraethyl lead, the Surgeon General prohibited the use of it in gasoline. The Ethyl Corporation and General Motors or their attorneys and Dupont went in and they made two tests. They took two young men who had never been around lead vapors and they checked their lead intake and excretion for a period of time and then they exposed them to a service station where about 10% of the sale of gasoline was leaded and they found no significant increase in their body metabolism for lead. They took two older men and did the same thing and when they put the older men back into this atmosphere, one of them began heavy lead excretion. But because he had been an automobile mechanic and his body had become loaded, in his bones, and his blood, and everywhere that lead can accumulate - liver and kidneys - it degenerates these organs, they said on the basis of three to one it was safe for the public to start breathing lead again. They didn't even know enough about it to know that it was accumulative poison in their bodies.

CHAIRMAN THELIN: It is your contention, Mr. Phillips, that the death rate is caused by lead in these districts that are on the map?

MR. PHILLIPS: An incipient poisoning of lead slowly destroys the liver and kidneys. Now the phosphorus lead affects the lungs because it is so small it lodges in it, but as these

organs degenerate and decrease the function of your body metabolism then anything else could be written on your death certificate when you were actually slowly poisoned. Now take for instance this case. There was a young medical student in Germany that thought he would inject mercury into his blood and he would die quickly. Now mercury is a known poison. Probably if he had swallowed this metallic mercury he would have had that effect. This man will slowly die and X-rays will show it in a period of about 20 years from the degeneration of his liver and kidneys from the effects of the mercury that he injected. He intended to commit a quick suicide, but he was subject to a lingering death, and you will die just as surely from small amounts of lead poisoning inhaled over a long period of time as you would if you swallowed the same amount of a less toxic lead.

CHAIRMAN THELIN: Mr. Phillips, are there any medical or scientific authorities who support the views that you have expounded relative to the condition of lead in our atmosphere in this area?

MR. PHILLIPS: I have private communications that I was asked not to divulge where public health officials said that one of the symptoms of air pollution poisoning was an incipient or almost a chronic type of lead poisoning.

CHAIRMAN THELIN: You cannot give us the source of this statement though.

MR. PHILLIPS: I can if I am required to.

CHAIRMAN THELIN: Well, I think we would be very interested in having that information if it is available to us. We have no process whereby we can force you to do so, but I think it would

be very helpful if you could do it.

MR. PHILLIPS: Well, if I did that it would probably destroy a man in public office that is trying his best to do something about this particular problem. I was destroyed out of the petroleum industry for suggesting to my company after my experiments that they could produce a clean fuel for this area. Now such a white unleaded gasoline is produced and made by the American Oil Company and will run the finest high compression engines. After 18 years with the company, I tried to get them to bring out a cleaner burning lead-free fuel for this and I was soon sacked. I would rather leave this man in office and let him continue his work than expose him to ridicule at this time, but I believe eventually that these facts will be proven beyond doubt. Now, one other thing, pardon me, I have this much proof. During the 1954 Grand Jury in Los Angeles County I was asked to contact John Kingsley the acting foreman of that Grand Jury by a gentleman in public office. I went out and I showed him the information I had and he said, "Mr. Phillips, I don't know whether you are right or wrong but I intend to find out if you will help me." I said, "I will gladly do so." He said, "Would you write out on paper questions that can be answered by Public Health officials, than can be answered by engineers, that can be answered by Air Pollution Control officials, that can be answered by doctors? I will subpoena those gentlemen before the Grand Jury and ask them." For two weeks he took this list of questions and he questioned these men. He called me up and said, "Would you come to my office?" I said I would. I went there and he said, "The testimony that I uncovered as to the effect of this investigation is so vital to the health and welfare

from the opinion of these people that I questioned that I want to put this on public record." He said, "Will you testify to the facts that you have given?" He said, "But I don't want that locked in Grand Jury secrecy. I believe that if I expose this to the public that they will become sufficiently alarmed that we can clean up air pollution in one big investigation."

CHAIRMAN THELIN: What was the name of this official?

MR. PHILLIPS: John Kingsley. He owns a stationery store in Pasadena. He now lives down in Balboa, I believe.

CHAIRMAN THELIN: Does any other member of the committee have any questions for Mr. Phillips?

MR. PHILLIPS: I'd like to just conclude this thing, if I may.

CHAIRMAN THELIN: All right, go ahead.

MR. PHILLIPS: He said, "Would you appear day after tomorrow and put this on record but swear to tell the truth since it is your research and your investigations into this, but reserve the right to discuss it with anyone? I've had this research validated by testing laboratories and various other means." I said I would gladly appear day after tomorrow. The next day, without invitation, Harold Sweitzer, Judge Harold Sweitzer, appeared before the Grand Jury and lectured them for two hours to drop the inquiry into "smog". When they refused to do so, he dismissed them. This is the first time a Grand Jury has ever been dismissed in the State of California. Other Grand Juries have been threatened by this and I was in a newspaperman's office that day while the Grand Jury was being dismissed. The telephone rang, and this man says, "In spite of everything we can do, it looks like the Grand Jury

is going to blow the lid off of "smog". But the public never got the facts. And these people never got to testify.

CHAIRMAN THELIN: Mr. Rumford, I believe, has some questions.

ASSEMBLYMAN RUMFORD: Would you give us some information on your background? Are you a chemist, a chemical engineer?

MR. PHILLIPS: I worked four years as a chemist -

ASSEMBLYMAN RUMFORD: Your education?

MR. PHILLIPS: I worked four years as a chemist in the petroleum industry.

ASSEMBLYMAN RUMFORD: What industry was this? What company did you work for?

MR. PHILLIPS: It was the Roxana Petroleum Company, Dallas, Texas. Approximately 3½ or 4 years- in that neighborhood. I also worked for the Dallas Laboratory as a chemist before I went with Roxana. I was building laboratory apparatus there for that company. I worked over 14 years with the Shell Oil Company. Approximately 3½ years in their refinery.

ASSEMBLYMAN RUMFORD: What were you doing there, Mr. Phillips?

MR. PHILLIPS: I was handling the paper work that went to the government that authorized the changes in the refinery for the allotment of critical materials to make those changes. I stood on top of the cat cracker the first day it started in operation in the Wilmington Refinery - I mean the Dominguez Refinery.

ASSEMBLYMAN RUMFORD: The formula for gasoline, we are talking about.

MR. PHILLIPS: Yes. I have earned by living for years as

an engineer. I have attended about four universities. When I was at the refinery, I took special courses to become familiar with the petroleum refining and technology and completed courses with a grade of "A" at our leading university.

ASSEMBLYMAN RUMFORD: Are you a graduate engineer?

MR. PHILLIPS: I have enough credits to be. But they are spread in several fields.

ASSEMBLYMAN RUMFORD: I have no further questions.

CHAIRMAN THELIN: Are there any other questions from members of the committee? Mr. Brown, Mr. Cameron? If not, we will thank you for your testimony, Mr. Phillips. We will let you go and I think the committee will take a break right here for a little lunch and be back at 1:30.

ASSEMBLYMAN RUMFORD: Will the meeting please come to order. Due to the fact that the chairman is momentarily delayed we will begin the meeting and turn it over to him when he arrives. Our next witness is Mr. Charles Willard who is the scientific and technical chairman of the Citizens Anti-Smog Committee. Mr. Willard.

MR. CHARLES WILLARD: Mr. Chairman, members of the committee, I am Charles Willard. You will want to know of my history. I will not bore you with a recitation of 50 years, things that I have done. I started my commercial life in the automotive industry, and was a member of the Society of Automotive Engineers when it was formed and for a long time. I have been invited by the company that made the submarines for the United States to design an engine for the United States submarines. I designed the prototype of the radial aircraft engines that were used continuously by the Army until recent years. I have been a consultant in engineering for the United States Army and Navy and internationally known in the automotive field. At the time of the large depression, some years back, I was obliged to devote myself to metallurgy and chemistry, which I had known because of engineering work. I owned and operated the largest electric chemical plant in the state. We built it ourselves and developed therein one of the most efficient electrolytic cells for oxidation that has ever been built. At the same time I operated the largest plant of its kind salvaging metals. We manufactured lead to the extent of ten or fifteen tons a day from storage batteries which is a basic snuffing operation. I therefore know lead. There also was operated in my plant a large zinc refining division and probably the largest aluminum salvaging

business in the city. Someone of you asked about school. I went to school. I studied French, German and Spanish and if my English is bad that is because of the studies of French, German, and Spanish.

You are going to be spoken to by a great many men, probably, if it is like the past, who have doctors degrees. I have employed a number of doctors of chemistry and physics, and I know them, and I want to say to you in sort of an advanced rebuttal the mere possession of the title "doctor" does not carry with it any signicance whatsoever of the man's ability to go outside of the sphere of his studies. Within the last three months talking to the sales department of one of the large chemical companies I was told to see Mr. so-and-so. I said, "Is he a doctor of chemistry?" And the answer was, "We do not allow our doctors of chemistry to interview the public anymore. We found that they are confined too much to their books." I am not going to deal with you in this parts per million business because you will get enough of it. Any statement that is made to you that lead poisoning is not serious is untruthful. There is no other way to describe it.

Lead poisoning is in the ancient historical books of metallurgy and this poison goes back a thousand years or more. The French Government barred the use of lead paint some fifty years ago because painters became poisoned in the way that was knows as painters colic, it was actually lead poisoning. A few years ago, maybe two years ago, our county medical department banned the sale of toys because they were painted with lead paint. And yet that same medical department came before you

today and put up a long mixed conversation as to whether or not the lead was poisonous. I am going to submit to you in writing references from reputable books. People who are not propagandists, people who are not wielding the words of the English language to confuse you or to make you think that lead poisoning is a mild thing. Mr. Phillips gave you a very fine resume of the situation this morning,and I just know enough about chemistry to say to you that he told you the facts. He is not here to sell you anything. Neither am I. We are proponents of the bill that is before you people. We are only asking for clean gasoline. In a conversation with a doctor of chemistry last week the subject of this lead poisoning came up, and he said, "If the people knew what goes on at the laboratory, they would immediately demand restriction in the use of the lead material in gasoline." His exact words or nearly exact words were, "The people should know how many men who are chasing butterflies up and down the river are on the pension rolls of this company." He further said, "Every so many days you will see a man with a little patch on his ear. He has been to the plant doctor and had a sample of his blood taken. And when they become loaded to a certain extent they very carefully are sent off to another department." And further, "If the public knew how many people that have worked in this business were loaded with lead to the point they had to be pensioned, people would no longer want this lead in the gasoline."

I want to point out to you, gentlemen, and you members of this board, that we in this county submit to some ten or fifteen tons of this material a day being distributed on our ground and over the two hundred odd days of dry weather that we

have, with no rain to bog it down into mud, it blows. They are quite truthful when they say to you, "Oh, well, there is lead over here in the reservoir and there is lead over here and there." Of course it's over there, how can it be elsewhere? There is bound to be lead. We want the elimination of it.

No later than yesterday I was in the chemical conference with a Ph.D. and a doctor of chemistry who is employed by one of the large oil companies. Inadvertently the subject of lead got loose. He said the refineries have cleaned up all the smog; there is no smog at the refineries. He should go up to the observatory in the morning and see it boiling up out over the refineries and then he would know. He said it is all up to the automobiles. I said, "What are you going to do with the lead that comes out? You are a chemist. You know you can't destroy an atom. There is no way to destroy an atom. You can chase the poor little thing around a cyclotron until it get dizzy and falls apart. But if you are way below the atom pieces that are left, possibly make allowance to the energy that has been lost, you'll find you have the same thing in the end as you had at the start. The matter is indestructible. What you put into the gasoline tank must come out of the tailpipe. Sulphur and lead." So he said these words, "Well, the oil industry is beginning to realize that in all probability lead will be outlawed in the not too distant future."

Now I want you to take the significance of that which merely means that the people who are going to come before you this afternoon know just as well as I do that lead is a poison. They know it just as well as I do. But they will distort the

English language for you to try to make you believe that which is not true. Now I thank you for your time and I will submit to you a list of references where, if you really want to know whether smog is poison - I mean, whether lead is poison or not, whether bromide is poison, and as Mr. Phillips showed you, quite correctly phosphorous with lead, phosphate, lead bromide and the whole dirty family are poisonous to your system. It is not a thing that is going to happen in a day or a week or a month. But if Dupont screens their people in the laboratory they do not do it just to keep the doctor busy. Nor do they pay pension to all these poor individuals whose brains have been idled by this stuff. I thank you.

CHAIRMAN THELIN: Just a moment, Mr. Willard, maybe there will be some questions. Are there any questions from members of the committee? There being none, thank you very much, sir.

MR. WILLARD: You are entirely welcome.

CHAIRMAN THELIN: The next witness will be Mrs. Clara McDonald. Mrs. McDonald will you come forward, please.

MRS. MC DONALD: Mr. Chairman, and members of the committee. First of all I want to ask the privilege of filing a statement submitted by Mr. West who could not stay.

CHAIRMAN THELIN: Very well. The sergeant will take the statement, Mrs. McDonald.

MRS. MC DONALD: Thank you very much.

CHAIRMAN THELIN: Will you state your affiliation and your name for the purpose of the record.

MRS. MC DONALD: First of all I want to say I am speaking from civic organization attitude representing Citizens Anti-Smog Action Committee, Incorporated, and also the United Patriotic

People of the U.S.A. My topic will be in the interest of preventing undesirable components from entering the automobile or truck fuel tanks. During the legislative session in Sacramento this year, we backed smog abatement and supported the enactment of AB 2335.

CATALYTIC CRACKING PROCESS

During the manufacture, gasoline produces nine times the amount of gasoline from the same crude oil that they used under the old process by refineries, thereby creating a greater complex analysis of the constituent parts of the gasoline, according to Mr. Houdry the inventor.

It is further believed greater chemical changes take place. With this inferior gasoline and its additives, the moisture and catalyst in the air, the sun's reaction upon it create higher potency in air pollution, because the sun must have solid in each molecule of water to reflect heat, thereby causing the chemical reaction that is so detrimental to our health. This has been proven in tests made over Chesepeake Bay on the east coast, as noted in the Los Angeles Times a few years ago. The theory was developed by a woman official for the U. S. Weather Bureau, Washington, D.C.

We give credit for the abatement of some air pollution. It is not enough however to use only part of the knowledge we now have on how to correct air pollution problems, particularly dangerous in the Los Angeles County and its contiguous areas.

The lack of control and economic waste, includes the County Board of Supervisors. They should grasp the significance of what has NOT been done, accept the responsibility, or the consequences.

ON STATE AND FEDERAL GOVERNMENT CONTROL

We realize the importance of states rights but, the federal government has recognized we are not taking sufficient hold of our problem within the limits time, to avoid continued illness and deaths, and now offer Senate 455 as a means of taking the issue out of politics and into the hands of the people for the removal of air contaminants should this step be deemed necessary.

AIR POLLUTION CONTROL IS THE RESPONSIBILITY OF THE STATE

From the Governor of the State, the State Legislature and all levels of government in California are the persons directly responsible for air pollution control, if not WHO IS?

We shall point out real cause and effects of air pollution, while waste, exploiting the people by draining vast tax monies from their economy and with continued tragedies commonly known to all of us.

ON LEAD

Public Health Bulletin No. 253 shows that 47.4 percent lead of what we breathe into the lungs stays there until death.

On additives now used in gasoline, as well as in the lubricating oil, it further increases our pollution, creates intolerable health conditions and deaths, according to the findings of engineers, chemists, and the majority of the medical profession.

I assume persons are barking up the wrong tree, in trying to switch the blame on an innocent automobile or truck; poisons from the refineries are placed in the air and must be omitted at its source of trouble, and without delay, unnecessarily, request the passage of AB 2335 for clean air.

The State Department of Public Health, Mr. S. Griswold, and the State's publication, Clean Air Quarterly, Sept., 1960 and California Safety News Bulletin for Dec., 1960 refer to insidious lead air poison used in low grade gasoline. Dr. John Middleton, Chairman of the Motor Vehicle Pollution Control Board, stated, "We need automobile devices with conformity to standards if it will work and we need clean gasoline." Stated August 11, 1961.

Dr. Haagen-Smit stated, "There is nothing wrong with the automotive industry." July 14, 1961.

CLEAN GASOLINE AND CLEAN FUEL MINUS POISON ADDITIVES

Being manufactured, sold and used back east.

Now, ladies and gentlemen, I want to give you documented evidence as presented by Mr. Chandler Phillips at the Senate Fact Finding Committee on Public Health, January 22 and 23, 1960 report. The references are from pages 51 to 61 inclusive:

> "When I told Dr. Haagen-Smit that a fuel with 5 times as much sulphur, or five times as much lead produced 5 times as much air pollution, he said, 'Yes I will have to agree with you'.
>
> "A catalytic plant went into operation in London, England. This plant processed 63,000,000 barrels of crude oil that year and 25,000 people died from sulfur fumes. This plant went into operation in Los Angeles area. We had to shut the plant down and double the precipitation.
>
> "When you burn with a sufficient amount of air, any sulfur compound, it appears as sulfur dioxide and sulfur trioxide. Afterburners will make that into a form that is readily absorbed by water vapor, to turn into acid form. One gallon of petroleum products will produce one gallon of water vapor and you immediately have in the stream the very things that combine to form materials that eat up your muffler and tail pipe. They eat up the lungs of your children, they combine with the dentine of your teeth and cause cavities. Sulfur acid DOES NOT DIE; England found

this out in a very TERRIFIC way.

"It is not necessary to go back to the sulfuric acid treatment, there are more methods of hydro cracking.

"Public Health Bulletin shows the experiments on animals with ordinary lead compounds are retained in the lungs, found 46.4 of that in the animals' lungs.

"A control device with low grade fuels will NOT eliminate lead.

"Hydrocarbons, reactive residuals are in unburned gasoline. If these were removed from the gasoline in the first place - and it could be so done at the refinery - then I believe an afterburner would not be necessary and an afterburner CANNOT DESTROY THE LEAD.

"Hydrocarbons are irritants.

"On automatic automotive control devices for the purpose that can best be accomplished by removing trouble makers in the gasoline 'at the refinery' in lieu of AB 2. Urge clean gasoline through the bill similar to AB 2912.

"The deep hydrogenation process necessary to clean up quality of the fuel, would be far less expensive and would NOT require costly inspection and many additional employees to pay for it.

"All the State Health Department has to do is start analyzing the lead phosphate in the people that are dying in the Los Angeles area. You can post your death records by date of death instead of when they are received and you will see a correlation in the death rate by the heavy smog incidence dates.

"Thank God there is one oil company known as the American Oil Company that makes a white unleaded gasoline that will run the finest high compression engine available today. I have a telegram from them. It is over 100 actane and contains NO lead and should be required in every metropolitan city that is suffering from smog today.

We ask the support of AB 2335 for the purpose of setting standards in the manufacture of gasoline and fuel, keeping lead and sulfur out of the automobile and truck fuel tank, out of the air and out of our lungs for CLEAN AIR. Also to prevent violations.

Ladies and gentlemen the second part which I will submit and that is already in my testimony submitted to the members, is on establishing responsibility within the state and on liabilities. To conserve on time I will offer it as submitted. I will be very happy to answer questions if I am able. Liability under the law. Section 24243, a Code applicable to air pollution and of our responsibility to that law:

> "A person shall not discharge from any source whatsoever such quantities of air contaminants of other material which would cause injury, detriment, nuisance or annoyance to any considerable number of persons or to the public of which endanger the comfort, repose, health or safety of any such persons or the public, or which cause or have a natural tendency to cause injury or damage to business or property."

VIOLATIONS

Any public official who violates this section of the law is equally guilty of negligence in the performance of his duty to prosecute violators, or who grant questionable variance to the violators, and further, that each succeeding violation will treble in penalty. The fourth violation 6 months or more, imprisonment in the state penitentiary. The punishment of offenders will assure equal responsibility to the public on the enforcement of the law by our elected officials. The punishment attitude of some officialdom on air pollution control appears to be vindication at all times, loss of records or, insufficient records to be prepared.

THE BEGINNING OF AIR POLLUTION CONTROL

All conditions of air pollution to be recognized in order to establish responsibility where it belongs all conditions defined, official positions defined on control of all violators of air control laws of municipal, private enterprise and corporations.

ESTABLISHING RESPONSIBILITY WITHIN THE STATE

For establishing the responsibility in the state, and extending its benefits, violators of air pollution laws, to be thoroughly documented and catalogued, and recorded.

In Los Angeles County under the present air pollution control enforcement, criminal liability cannot easily be established for the reason in housing, industry, etc., the laws require equal responsibility between the public and owners and should include the elected officials and their agencies, for there is not enough public information available at all times to establish criminal negligence, malfeasance and misfeasance, etc., that are not here considered in their true sense. Criminal liability for deaths and permanent injury to health are in a separate category - malfeasance, etc., come later.

Elected officials subject to the same penalty and to be held equally responsible to create a 'balance in responsibility'.

SULFUR AND LEAD AND METALLIC ADDITIVES DANGEROUS

The state to be held equally responsible to create a balance of shared responsibility. It has been a war on people in allowing violations which cause physical illness, maiming of our people through respiratory condition for the balance of their lives or death. To remedy to a great degree, recommend

the passage of AB 2335 in the interest of preventing undesirable components from entering the automobile, vehicle, or truck fuel tanks.

CHAIRMAN THELIN: Thank you very much, Mrs. McDonald. Your statement will be received. Are there any questions for Mrs. McDonald from members of the committee? Mr. Cameron has a question.

ASSEMBLYMAN CAMERON: Mrs. McDonald, you seem to have injected something here in the testimony that I haven't noticed heretofore with regard to hydrocarbons. Is it the contention of your organization that lead and the other additive compounds are the sole cause of air pollution and that the hydrocarbons are not?

MRS. MC DONALD: Mr. Phillips would be the best man to answer that question. However, it is our belief that if these additives were omitted you wouldn't have the problem with the residuals and hydrocarbons in the exhaust.

ASSEMBLYMAN CAMERON: You mean that by the removal of the additives to petroleum products that this would automatically remove the hydrocarbons and the olefin?

MRS. MC DONALD: There wouldn't be those hydrocarbons. The hydrocarbons with additives are of that nature which are metallic, will gum up the automobile. There is your problem. We want to avoid that problem at its source and provide clean gasoline.

ASSEMBLYMAN CAMERON: Well, you quoted quite extensively there from Dr. Haagen-Smit in your presentation and is this in conformity with Dr. Haagen-Smit's theory with regard to the chemical reaction that causes air pollution as we know here in the Los Angeles basin? Mr. Phillips, would you come forward?

CHAIRMAN THELIN: Mr. Phillips, will you come forward and help out a little here?

MR. PHILLIPS: I think the answer to your question is this, that to have a cleaner fuel that won't knock in the motor, a large part of that fuel would have quite a bit of the reactive hydrocarbon removed. However, if you notice the bill proposed to you, we proposed the sulphuric acid heat of reaction to determine the reactive hydrocarbons in the fuel and control of this method, because this is the most effective way to do it and this takes in those particular reactive hydrocarbons that Dr. Haagen-Smit is speaking about that create the smog effect by the chemical reaction with the presence of nitrious oxides.

ASSEMBLYMAN CAMERON: Then it is your contention that a catalytic process or cracking process of some sort is available, that not only would it make it possible to remove but would make it possible to eliminate the necessity for all additives and at the same time would take from the fuel itself the reactive hydrocarbons. Is this correct?

MR. PHILLIPS: Such a process is now available. It takes a reactive hydrocarbon and olefin and combines it with a saturated carbon hydrocarbon and produces a chemical known as iso-octane, which has a rating of 100 percent of 100 anti-knock rating. It contains no lead as used in the reference for checking the proponents of all fuels produced by the refinery.

ASSEMBLYMAN CAMERON: Now, what about the further burning of this fuel in an internal combustion engine in the effect that this would have on the release of additional hydrocarbon compounds or olefin compounds that were not present in the

refined fuel that are present in the combusted fuel.

MR. PHILLIPS: Two studies have been made on that compared to my original research which proved that by cleaning up the fuel with a 98 percent sulfuric acid treatment that the ability of the fuel to pollute the air was directly related to its acid head of reaction. Now the air pollution control district with research of Dr. Matter has proved that a fuel not completely cleaned up but with a lower olefin content would not produce as many air pollutants by approximately two-thirds. The Bureau of Mines have also found out - and this was taking the fuel and combusting it in the engine then irradiating it for two hours with sunlight and bringing it back and checking it - and they found that a cleaner fuel did not produce this photochemical reaction. The Bureau of Mines also found out that using iso-octane, which I have just mentioned to you - as a motor fuel compared with present day motor fuels, that air pollution could be reduced on approximately an eight fold reduction.

ASSEMBLYMAN CAMERON: And it is your contention that these fuels can be produced from the crudes that are available in the market area in Southern California with a great variance and specific gravities of the crudes available?

MR. PHILLIPS: Yes, this will require hydro cracking process to remove these from the fuels. But the oil company receives an increased yield by doing such a process.

ASSEMBLYMAN CAMERON: Increased yield in what sense?

MR. PHILLIPS: Increased yield of more products. They combine hydrogen with it and the olefins become saturated hydrocarbons which do not have this ability to react and the

impurities of nitrogen and sulfur are removed and can be sold commercially.

ASSEMBLYMAN CAMERON: Is this the process that is being used by the American Oil Company you keep referring to?

MR. PHILLIPS: I imagine it is partially being used by oil companies in this area, but not to an extent great enough --

ASSEMBLYMAN CAMERON: This is not an answer to my question, sir, - my question is what is the American Oil Company doing that makes their fuel so distinct and different from that that is available by other companies?

MR. PHILLIPS: Well, I can't answer that question on what they are doing in their refineries, because I don't know, I've never been there.

ASSEMBLYMAN CAMERON: Your favorable comment to the American Oil Company then is solely attributable to a 1954 advertisement in Life Magazine?

MR. PHILLIPS: No, not solely. There is no reason why if one company can do it that another can't do it.

ASSEMBLYMAN CAMERON: You are not aware of what the specific gravity or the type of crude is that they are using from which they are producing this unleaded fuel.

MR. PHILLIPS: I am aware that they are producing it in Texas and I am also aware that the Shell Oil Company has some very high crudes from West Texas that they have sulfur removal plants and they are making competitive products with them now. So I would say that that could be done with any type crude if they are willing to hydrogenate it.

ASSEMBLYMAN CAMERON: This is not based upon any specific

technical knowledge, though, as to what American Oil Company is or is not doing, but this is rather an assumption that you are making based upon your engineering background, is this correct?

MR. PHILLIPS: No, I know the quality and what the composition is fairly well of the American Oil Company's gasoline, but I do know they are making right in this area iso-octane which is even superior to the American Oil Company. We make it in Wilmington refinery. And this does not produce air pollution as proven by tests by the Bureau of Mines. So I see no reason why this process cannot be expanded and by a slow method of changing this that there is no big economic dislocation to the oil companies. It will cost maybe a half million dollars just to put devices on the tailpipes of cars, and hundreds of employees to check and you will have only at best a device that will save 50% average efficiency. If you can reduce air pollution eight fold or even two-thirds by a cleaner fuel at a cost to the oil companies that they have already estimated, it is about one-fourth the amount the public will have to spend for afterburners. It certainly seems that this is a better method to proceed or a way to proceed.

ASSEMBLYMAN CAMERON: Thank you, sir.

MRS. MC DONALD: Mr. Cameron, I would like to answer one part of that question wherein the American Oil Company has given us the information that their set standards in the manufacture of their gasoline conforms with the bill as set forth in our request AB 2335.

CHAIRMAN THELIN: Thank you, Mrs. McDonald. Thank you, Mr. Phillips. Just a moment. There are more questions,

Mrs. McDonald.

ASSEMBLYMAN BROWN: This isn't a question, Mr. Thelin, but I think it would be appropriate at this time for me to submit for the record a letter from the American Oil Company in which they refuse detailed information on the specifications to me, as the author of this bill, and in an earlier letter, they did indicate that their gasoline did conform to the specification set forth but they would not give specific information.

CHAIRMAN THELIN: May I see the letter? This is a letter addressed to the Honorable George Brown, dated July 27, 1961, from the American Oil Company, signed by Mr. Miller. We will accept this as an exhibit. Are there any questions now of Mrs. McDonald from members of the committee? Mrs. McDonald you may be excused. Thank you so much. Thank you, Mr. Phillips. Mrs. McFarland, are you present? Would you step forward please and testify? Mrs. McFarland would you begin by stating your name and your organization, if you represent one.

MRS. MC FARLAND: I'm Mrs. Margaret McFarland and I represent the Property Protectors Salvation. I'm a retired high school teacher and very much interested in the smog situation. There seems to be considerable confusion on smog today in Los Angeles about the definition of smog itself. Originally the term smog included all types of air pollutant including those you can't see as well as those you can. But lately the air pollution control district has seemed to concern itself primarily, if not entirely, with the visible hydrocarbons in the air which are claimed to be mainly the result of imperfect combustion. It's from this point of view that they are

advocating adoption of a device attached to the cars which will dispose of this unburned visible residue. But clearing the air while it might make Los Angeles prettier and a more pleasant place to live will not make it any safer. Clearing the air won't help smog sufferers the slightest bit. What we want isn't just clear air but clean air. The pollutants which smart the eyes and choke the lungs, and if they include lead, sulfur, phosphorus, they are bringing suffering and death to residents of this area. It cannot be destroyed by any mechanical device. In fact, once put into or left in the gasoline at the cracking plant they can't be destroyed by combustion means at all. Sulfur, lead, and a whole list of invisible elements in exhaust fumes will continue to be released into the air so long as they are left in gasoline to poison those who breathe this. No matter how effectively you clear the air in Los Angeles, the only sure and reasonable way to remove those poisons is not to put them in at the refinery in the first place. So I repeat, what we want isn't just clear air but clean air. We ask you to protect the lives and health of the citizens of Los Angeles and other smog afflicted areas in California by recommending the passage of AB 2335 which will give us clean air, clean gasoline, free from pollutants.

CHAIRMAN THELIN: Are there any questions of Mrs. McFarland? There being none, we will excuse you Mrs. McFarland. Thank you for your testimony. Mr. George Fisher.

MR. FISHER: Mr. Chairman, I am George Fisher, Secretary of the Southern California Taxpayers Council. Our organization is a political organization for simplified government. We are

an offshoot of the 1957 tax revolt and have since blanketed not only Los Angeles County but Southern California on a political basis dealing with tax matters primarily. Since 1955 we have been interested in smog and we have joined with most of the people that you have previously heard from our side of the aisle. I'm not going to pretend to follow Mr. Phillips with any type of scientific information. It would be painting the lily to do so. Not only am I unqualified to do so but he seems to have covered the field and he represents the scientific angle of our entire program. He furnished the basis for the bill, AB 2335, and scientific testimony from the Western Oil and Gas Company and the APCD here in Los Angeles County have all been stated previously in substance by Mr. Chandler Phillips. In other words, the things that he told us in 1955 are now being verified by our own air pollution control district and by the engineer of the Western Oil and Gas Company.

Now, our organization is not on anybody's payroll. Every one of us has sunk thousands of dollars - not all sunk thousands, we all haven't had it - a great number of us have sunk thousands of dollars into this merely because we think it is a good fight. I personally have done so. I have nothing to gain from it, neither has Mr. Phillips, nor Mr. Willard, nor any of the people. We are in this because we think it's a good public service fight, and that's it.

After that introduction, I may add that I'm a graduate in industrial engineering from the University of Chicago. I don't think that is of any value. I have been in the industrial world all of my life and I find that degrees or schooling is

absolutely a minus quantity as regards judging a man's qualifications. But anyway since it seems fashionable for one to parade his alphabet soup, I might add mine, that I do, unboastfully, have a degree in industrial engineering. Since I am an industrial engineer I'm going to try to divert somewhat from what has been said. I'm going to talk something about the economics of this thing. I'm going to say just one thing. It may take me a few words to say it, but I want to point out in advance that I'm only going to say one thing. Our opponents, the oil industry, have said repeatedly through their representatives that, "Oh, yes, we can clean up the gasoline, we can clean up the oil, but it is going to cost us money. It's going to cost the industry money and therefore it is going to cost the public money." Mr. Griswold of the APCD has just very recently taken up that song. He said it is going to cost us 48 million dollars a year. That is what the oil industry is going to have to spend to clean up the gasoline. Forty-eight million dollars. And naturally that is what the public will have to pay, because, of course, the public will have to pay in the end. Now, this is the thing that I'm going to say. I'm going to way that that represents a scientific, technical, and an economic fallacy. There is no relationship between that and what you and I pay for the gasoline we put in our tanks. There is no relationship between that and the cost of production. Now, I have done enough industrial engineering estimating to know that the oil industry does not price its gasoline to any degree at all in regard to its cost of production. That is particularly true here on the west coast. West

Coast gasoline - the West Coast gasoline business is a veritable gold mine. We pull the crude out of the ground here and we market it here. There is no transportation cost. The price that we find on the pumps of our gasoline stations here are arrived at by every factor in the world except cost of production. Supply and demand, seasonality, conditions inside the market of various kinds, what the traffic will bear, there are a dozen intangible and abstract factors, business factors that enter into the cost to the price of gasoline. And those prices are fixed. They are not regulated by supply and demand. When you go out and look at the price of gasoline at a major station's gas pump you find they match the prices of a major competitor's gas pump. Now, when you look at the prices of a minor gas pump, one of the minor companies, they also are in line, they are a few cents lower and that differential is arrived at very carefully and very scientifically by the oil industry as a whole. The minors are allowed to sell their gasoline at a certain price, so many pennies below the price of major gasoline. Now, a lot of factors enter in, but when the petroleum engineers tell you that selling clean gas is going to cost us so many dollars, so many millions of dollars, it is simply not true; it is just as big a fallacy as it is for the Motor Vehicle Control Board to tell us that a gadget for the tail end of our cars should cost, well let's see, well how much will the public pay, 35 - oh I think we can soak them 100, well, maybe 200, it depends. We will feel them out; we will see how much they'll stand; we will try it at 50, publish that figure and let them respond and if they kick too much, we will lower it. In other words,

all this baloney about pricing a muffler device is absolutely fictitious. You can't price anything until you get it off the drawing board; any engineer knows that, whether he is an industrial engineer or a petroleum engineer or a chemical engineer, you have got to get it off the drawing board, and you have got to get it off the specification sheets, and then you have got to see what it costs to produce it. If it has valuable components in it, it is going to be expensive; if it is nothing but a machine shop job, it's going to be cheap. Now, as of today, we haven't the slightest idea what is going into that muffler device; there isn't an engineer in Detroit who knows what is going into that muffler device.

The Automotive News Engineer a few months ago stated in his publication that Los Angeles is demanding a muffler device. Not only is it not off the drawing board, it isn't even out of the heads of the inventors as yet, and still those smart boys out in Los Angeles are already pricing it, telling us what it is going to cost. That is merely a side line. We are not here to talk about exhaust devices, but it just gives you an idea of the type of fictitiousness that does enter this economic angle. So I want to make that one point, and I am going to quit, if I can get one point across to you, and that is when they tell us that they can give us clean gas, give us clean fuel, but it is going to cost us money, it is simply not true and has no basis whatever in fact.

CHAIRMAN THELIN: Do any members of the committee have a question of Mr. Fisher? Mr. Fisher, where did you say you took your engineering degree?

MR FISHER: University of Chicago in 1915.

CHAIRMAN THELIN: Thank you very much. We will now call a representative of the Ethyl Corporation, Mr. Hesselberg, would you care to step forward please? Mr. Hesselberg has filed with the committee his statement which he is now going to read to us. Will you state your name, sir, and your position?

MR. HESSELBERG: Mr. Chairman, I am Howard E. Hesselberg, Ethyl Corporation Research and Development Department, and I would like to comment on a subject that has had discussion, and that is the lead anti-knock compound concentration of California motor gasoline.

I believe before commenting, however, that it might be in order to discuss the reasons these compounds are an essential component of the fuels currently produced. Since they were first marketed in 1920 their use has become almost universal, both here and abroad. In the United States, currently, over 99½% of all motor gasoline contains lead anti-knock compounds which are used for the purpose of raising the anti-knock quality of gasoline to the level necessary for satisfactory operation of today's cars at the lowest possible cost to the consumer. If lead anti-knock compounds were removed from currently produced gasoline with no change in refining processing, the average quality of both regular and premium gasolines in the United States would drop by more than eight octane numbers. This would be the equivalent of rolling gasoline quality back to the level of about ten years ago. Our estimates indicate that if this increment of anti-knock quality had not been available to permit increased efficiency of our current automotive equipment, today's motoring public would

need to use at least 10% more gasoline than it currently does.

Anti-knock compounds provide maximum operating flexibility so that crude oil can be used most effectively. It is estimated that this flexibility plus the increased efficiency resulting results in the conservation of about 250 million barrels of our crude oil reserve each year. The use of lead anti-knock compounds also permit the savings of untold millions of dollars in capital investments which would be required to improve anti-knock quality by increased processing. All of this results in the savings of millions of dollars daily to the public and is reflected in current gasoline costs.

Of special importance, we believe, is the fact that in times of national emergency, lead anti-knock compounds are of vital necessity in the production of the increased quantities of gasoline of adequate quality for both military and civilian transportation. Now, as to the amount of lead anti-knock compounds which a refinery includes in its finished gasoline, this varies widely; it depends on the individual refiner, his balance between gasoline and other products which he makes, and it even has a seasonal variation.

In the State of California, our estimates based on gasoline which we have sampled this September indicate that on the average, premium gasoline contains 2.33 milliliters per gallon and regular grades 1.64. Weighting these in accord with their sales ratios gives an average lead anti-knock concentration of 1.95 milliliters per gallon. The corresponding average of the nation is 1.94, so California and the nation are running pretty close as of September.

Possibly to orient those of you who might not be familiar with the milliliter terminology which is one that is used in the industry, one fluid ounce contains approximately 30 milliliters; therefore, in the average gallon of gasoline sole in the State of California now, there is present about 1/15 of 1 fluid ounce of lead anti-knock compound. In addition to the lead anti-knock compound, the commercial anti-knock fluids contain ethylene dibromide and ethylene dichloride. These compounds are included in the anti-knock formulation to convert the decomposition product of the lead anti-knock compound to a form where they do not readily accumulate on certain engine components. On a volume basis, the ethylene dibromide is about 1/5 of the lead anti-knock compound and the ethylene dichloride is about 2/5. Summarizing, the use of these small concentrations of lead anti-knock compounds permit production of the economical gasoline now available to your motoring public. Any limitations on their usage would result in substantial increases in the cost of gasoline. Furthermore, any such restrictions would seriously impair the ability to supply the increased quantities of fuel that would be required in event of a national emergency. Mr. Chairman, this concludes my remarks relative to the anti-knock concentration. I would welcome an opportunity to answer questions. I would further request that since in recent weeks in the Los Angeles area there have been statements relative to certain other aspects of the use of lead anti-knock compounds, specifically as regards catalytic converter performance and also other aspects of engine operation, that if I might read into your record a

statement on these points, I have a prepared statement and I will try and make it short.

CHAIRMAN THELIN: You wish to make an oral presentation?

MR. HESSELBERG: Oral presentation of the more complete one; on these other subjects, but as I say, I will answer questions on concentration first, if I may.

CHAIRMAN THELIN: First of all, could you give us a little more of your own personal background in this field?

MR. HESSELBERG: I am a graduate mechanical engineer of the University of Missouri, 1940. I have been employed by the Ethyl Corporation in their research and development activities since graduation in 1940 with the exception of a stay of about five years with the military.

CHAIRMAN THELIN: You were present when Mr. Phillips testified, I assume?

MR. HESSELBERG: I was.

CHAIRMAN THELIN: You heard his remarks regarding iso-octane?

MR. HESSELBERG: Yes, I am quite familiar with iso-octane.

CHAIRMAN THELIN: Can you tell us anything about that, and what your reactions are to his views concerning the use of that?

MR. HESSELBERG: I would like to comment initially that iso-octane was invented and first produced by an ex-vice president of research of the Ethyl Corporation and was developed to use as a yardstick in the measurement of fuel anti-knock qualities. It was a component of much of the high anti-knock quality fuel that was used. A close variant of iso-octane was a component of

the high anti-knock fuel used during the war. In fact, commercial production was developed then. It is still a component. As to its production on a mass basis, I am not a refinery man, and I think possibly there are people more qualified in the audience to comment on the feasibility of producing enough iso-octane to supply your six or seven million gallons a day that would be more in order.

CHAIRMAN THELIN: You apparently are convinced if you eliminated the anti-knock compounds that the price to the public would go up considerably?

MR. HESSELBERG: It certainly is going to go up to the man that is going to have to make the gasoline, and I think normal economics indicate that a certain percentage of this increase would be expected to be passed on to the consumer.

CHAIRMAN THELIN: You feel that the factors of production and so on do have something to do with the price we pay for gasoline?

MR. HESSELBERG: This is true in our business.

CHAIRMAN THELIN: As I heard your testimony, you would state that we don't have any higher concentration of the lead anti-knock elements in California than they have elsewhere in the nation?

MR. HESSELBERG: In September we just had these data available and I thought since this was a current hearing, it was pertinent to the State of California. These were the best data that might be presented. This varies seasonally. There are times when certain areas of the State of California have higher average TEL concentration than other areas of the country. As I

commented before, the use of anti-knock compound is subject to a lot of variables and by and large I think that in Los Angeles it is true that there is, because of the specific refinery situation here, somewhat more lead used than in certain other areas of the country.

CHAIRMAN THELIN: Perhaps this isn't a proper question. If you feel it is not, just say so, but your corporation apparently is concerned with the problem of measuring the lead content in the atmosphere and things of that nature?

MR. HESSELBERG: We are currently cooperating with the U. S. Public Health Service in the project that was referred to by Mr. Maga earlier. I think Dr. Kehoe, whom I wish to introduce at the conclusion of this, is going to comment on this type of activity which we have carried out for some thirty years.

CHAIRMAN THELIN: I am interested in remarks Mr. Phillips made relative to the way this is done and his feeling is apparently that it is not being done properly. Will Dr. Kehoe be the proper person to address this question, or would you care to comment?

MR. HESSELBERG: As somewhat a layman in the analytical field, I am not qualified as an analytical chemist. I have been involved in a lot of this work and we believe that the procedures that are employed by the U. S. Public Health Service, the State of California, the district here, and other responsible agencies are quite capable of determining the amount of particulate lead that is present in the atmosphere. In fact, I believe much of the development of these techniques was carried out in Dr. Kehoe's Kettering laboratory.

CHAIRMAN THELIN: Are there any questions from members of the committee? Mr. Cameron.

ASSEMBLYMAN CAMERON: Mr. Hesselberg, if you can be objective about putting the Ethyl Corporation out of business -

MR. HESSELBERG: I would hesitate to do that sir.

ASSEMBLYMAN CAMERON: You mention in here - in your statement that there would be some eight octane points decrease if there was no change in refining process and if you left out of the anti-knock compounds -

MR. HESSELBERG: This is an estimate nationwide. This is not based on California.

ASSEMBLYMAN CAMERON: Is it technologically possible to bring that octane rating back up without anti-knock compound being added?

MR. HESSELBERG: It is at an increase -

ASSEMBLYMAN CAMERON: I am not concerned about cost at this time. We are talking about lives instead of money right at the minute. Now, you mentioned that 99.5% of the gasoline refined in this country uses some type of anti-knock compound. What is the other half of one percent, why doesn't it use it?

MR. HESSELBERG: This is, I believe, largely made up of the fuel referred to earlier before your committee which is the unleaded premium marketed by the American Oil Company.

ASSEMBLYMAN CAMERON: Now, why are they able to market competitively and other companies are not?

MR. HESSELBERG: Number one, they have historically obtained a premium for that gasoline above cost in areas where they market. They charge a one cent premium above the cost of

competitive fuels of equal other qualities -

ASSEMBLYMAN CAMERON: Just like Union Oil Company. Union Oil Company survives out here on a penny premium. Now, what else do they do?

MR. HESSELBERG: I can't speak directly for them. They happen to be very good customers of our. They produce large quantities of other fuels. That unleaded premium of theirs is only one of their products and they use considerable quantities of lead in the other gasolines that they market, both the regular grade and the fleet grade gasolines which are sold to commercial accounts.

ASSEMBLYMAN CAMERON: Do you have any indication that the quality of the crudes they are using is substantially different from that other refiners are using?

MR. HESSELBERG: Again, not being a refinery man, I can only comment that I don't feel that their specific crudes are a factor. I don't think it is primarily a question of crude.

ASSEMBLYMAN CAMERON: We get back to cost now. You are talking about a penny a gallon.

MR. HESSELBERG: This is the additional premium they obtain for the additional processing that they have with the balance of a very large amount of fuel in which they do employ considerable quantities of tetraethyl to improve its anti-knock quality.

ASSEMBLYMAN CAMERON: What you are saying now then is that the byproduct that they get is the result of this non-leaded material and yet they use more lead in order to bring it up to a salable product, is that correct?

MR. HESSELBERG: More lead is kind of relative; they use substantial quantities. I don't know if it would be more than what they would if they incorporated an anti-knock quality of anit-knock compound in ths -

ASSEMBLYMAN CAMERON: You are saying that the one cent differential is not a significant figure, but rather what would be significant is what do I do with all this fuel that I can't refine up to whatever this octane rating is that is necessary?

MR. HESSELBERG: I think this would concern a refiner that was in that situation.

ASSEMBLYMAN CAMERON: Which would amount to a number of gallons for every gallon or something like this, is this what you are saying?

MR. HESSELBERG: I think one way of commenting on this is the fact that the petroleum industry is extremely competitive and the fact still remains that 99.5 plus percent of all the refining industry still utilizes lead anti-knock compounds. I think if they felt there were an advantage to be gained you would probably see more people doing the same thing.

ASSEMBLYMAN CAMERON: Are we talking about economic advantages or sociological advantages?

MR. HESSELBERG: I am not sure if I -

ASSEMBLYMAN CAMERON: You used the word advantage, I didn't.

MR. HESSELBERG: It is a little hard to pick that one up.

ASSEMBLYMAN CAMERON: One other thing that was developed here by Mrs. McDonald, which I would like to have you clarify if you can. Is it your judgment that the refining process used

by American Oil Company or that would be required to bring the octane rating back if the anti-knock compounds were not added, would in fact remove the unsaturated hydrocarbon and the olefins that are currently being credited with being the source of photochemical smog?

MR. HESSELBERG: I don't know what a hydrocarbon type analysis runs on the iso-octane fuel currently, but the last ones I saw indicated that they had substantial quantities of olefins in their fuel as well as aromatic hydrocarbons.

ASSEMBLYMAN CAMERON: When you say substantial quantities, will you give us an index to compare substantial with? Substantial in relation to what?

MR. HESSELBERG: Well, I think they could meet your thirty number. Again, I do not have these data available. I hate to quote from memory on something that might feed back to as I say, a major customer of ours.

ASSEMBLYMAN CAMERON: Let's get Amco out of this picture completely then. We are not discussing them at all, we are changing the refining process in order to bring it back up to where we can hit this 100 octane without any additives. Does this changing in process eliminate a substantial portion of the hydrocarbons that are the cause of photochemical reaction smog?

MR. HESSELBERG: Again, I wish I were a refinery expert more so than I am -

ASSEMBLYMAN CAMERON: Take the objective about putting you out of business here -

MR. HESSELBERG: We are not very favorably inclined toward that objective. Let me put it this way, to maintain

the quantities of gasoline that is necessary in the State of California, the other characteristics of gasoline quality which include volatility and the other things you are aware of that you can get them started and keep them running, and completely eliminate the olefins -

ASSEMBLYMAN CAMERON: I am not asking for a complete elimination, I am asking you, would this process make a substantial elimination, or a partial elimination - would it eliminate any?

MR. HESSELBERG: I don't think it necessarily would, but this is a very qualified statement. I think there are people from the petroleum industry here that are much more conversant and I think they are going to be on the program, and it might be well to raise it with them and let somebody closer to a refinery answer than me, if you will.

ASSEMBLYMAN CAMERON: Thank you very much. Are there any more questions?

ASSEMBLYMAN BROWN: No, I want to hear the remainder of his statement, however, with regard to the catalyst.

MR. HESSELBERG: I would like your permission to brief it a bit. The reason we felt this might be in order was that there had been conversation on this. I think we ought to establish the fact that we have had some experience in this area. We have had a major research program under way in our laboratories for several years now aimed at the development of these devices. To indicate the scope of this program, we have ourselves conducted about a quarter of a million miles of actual road testing in a number of vehicles with a number of

different container designs. We have accumulated almost 40,000 hours of engine dynamometer time; we have had extensive laboratory chemical analytical backup; we have actually bench screened almost 2,000 potential catalysts. In the course of this program, we think we have learned a few things about the factors that go into the determining catalyst performance. These relate to the vehicle that we put it on, the container that you put it in, the auxiliary equipment, such as air supply, and a few other things such as the method in which you operate the vehicle. We have learned that of major importance is the specific active catalyst and the manner in which you support it. These catalysts have to be designed for the environment in which they are being developed to operate. And in this regard, and I think that this has been called to the attention of many people out here, the catalytic exhaust system is based on noble metals which were tested in the mid-fifties at the request of the Air Pollution Foundation. They used catalysts developed for certain industrial applications where gasoline powered vehicles were operated indoors. These catalysts that were used were developed to operate on the nonleaded fuels these vehicles used. When these catalysts were operated on fuels containing TEL on the road, it was found that their activity declined quickly, and there is no question that with these specific catalysts the loss in activity was due to the presence of the decomposition products of the lead anti-knock compound. However, it wasn't established then or subsequently to our knowledge that even these devices operated on nonleaded fuels would have met your current state criteria as far as device

performance, life, cost and all of the other factors.

In our own catalyst program we have aimed at the development of a practical catalyst that will operate on the fuels currently available. The availability of lead alkyl compounds as we have pointed out permits the fuels that are currently used, and again this 99.5 per cent figure which is a pretty major percentage of all the fuels available in the state. Therefore, our research as well as most other organizations active in exhaust catalyst development has been carried out on normally leaded fuels. The results of our program, again as well as many public statements made out here by others in this field, indicate that systems can be developed which will do a job on normally available leaded fuels. It has been announced that several of these devices are currently under test by your State Motor Vehicle Pollution Control Board. These devices will not require more expensive fuels and in addition they would not raise the problem which could arise on cross country trips in areas where these special fuels might not be available.

As far as our own investigations on some of the aspects of catalysts, one of the most important characteristics of a catalyst is its ability to become effective quickly after a cold start. The recently developed state criteria for device performance reflect this and have placed great emphasis on this property in the standard test procedure. This quality is particularly important because hydrocarbon emissions from the vehicle are at their highest at the cold start, and the catalyst has not yet received sufficient heat from the exhaust stream for it to become active and start oxidizing. For these reasons

the temperature at which catalysts should become active should be as low as possible and should stay low during the life of the device. In view of this critical feature of catalyst performance, we have developed a laboratory engine test procedure in which we compare this activation temperature, as we define it, of different catalysts. We define activation temperature at the time when the bed of the catalyst rapidly starts to exceed the temperature of the gas that is coming into it, indicating that combustion is taking place on the surface of the catalyst, and therefore you are becoming active as far as oxidation is concerned. And we have studied what might be expected in the possible effect of lead compounds on activation temperature on a number of catalyst systems which we feel have some promise. We have done this by operating them under this same procedure on unleaded and leaded fuels. Now, while we have found that there is some increase in activation temperature with continued operation in nearly all the systems we have studied, we have found in our studies that the presence or absence of anti-knock compounds is not a factor. On the contrary, I guess we were lucky in this one, with one system where in over 100 hours of operation we found that the activation temperature increased about 50 degrees when we operated on a clear fuel, and we experienced a small beneficial decrease in activation temperature when this same catalyst was operated on the same fuel except that it contained a lead anti-knock compound. The other major factor regarding catalyst performance is service life and we feel here that only actual road evaluation under realistic operating conditions can be relied upon to

establish how long any device will meet the established state criteria. This is due to the inter-relationships and effects of all these many factors I mentioned earlier and we feel the only way to find it out is to test it realistically on the road.

We believe that while the laboratory tests that many of us in the business use are valuable in establishing certain relative performance features such as comparing A with B and particularly in regards to activation temperature, we do not believe that these laboratory data can be extrapolated to predict practical service life. It is our conviction that catalytic devices can be developed which will operate successfully on the fuels normally available and that the increased gasoline cost which would be imposed if limitations were placed on anti-knock compounds would not be necessary.

This is the statement on our catalyst, and I have one further one which I mentioned earlier, Mr. Chairman, on other aspects of engine operation which in brief will be for the record.

CHAIRMAN THELIN: Are there any questions of Mr. Hesselberg?

ASSEMBLYMAN CAMERON: Mr. Hesselberg, I apologize to you for not being here when you started your conversation and I hope you didn't answer this question.

MR. HESSELBERG: I just tried to establish that we have been in the business for a while.

ASSEMBLYMAN CAMERON: I know you have. What I am concerned about though, you talk about service life - what has your research indicated with regard to the poisoning of any

catalyst that might be available by anti-knock compound?

MR. HESSELBERG: We have not carried out any actual road testing other than normally leaded fuels. As I stated, we feel that the overall requirements are for the performance of these devices, whatever type they may be, direct flame or catalytic, on the fuels that are normally available. We feel that normally available fuels are leaded fuels so I -

ASSEMBLYMAN CAMERON: I accept all of this, sir, and I agree with you. My question though goes to the fact that do you find leaded fuels in fact poison catalysts in your laboratory experience more rapidly than do unleaded fuels?

MR. HESSELBERG: We have conducted essentially all of our work on leaded fuels. We have stuck by this, we felt that this is what we had to beat, the use of them and I am not in a position to comment on this thing because we have no realistic data on the effect of clear or unleaded versus leaded fuel.

ASSEMBLYMAN BROWN: Well, you are familiar with the statement which originated with the Air Pollution Control District that the anti-knock compounds did have this effect of poisoning catalysts?

MR. HESSELBERG: Yes, I am.

ASSEMBLYMAN BROWN: And you, therefore, I presume you are not in a position to either deny or affirm if this is true on a basis of your own experiments?

MR. HESSELBERG: We do not have data, so I can neither deny or affirm the statement.

CHAIRMAN THELIN: If there are no more questions, Mr. Hesselberg - are you going to file something or are you

going to talk?

MR. HESSELBERG: I don't have anything to file, I just scribbled it together.

This relates, and I will be very brief in this, to the question of lead being a contributor to air pollution per se because of the possibility of engine component malfunction as the result of the use of anti-knock compounds. I think we probably will hear more about this later. It was referred to in the report mentioned by Assemblyman Brown made by Mr. Griswold which appeared several weeks back.

I think that the reference may have been to spark plugs misfiring as the result of deposit built up on the plugs and if you have a misfiring plug, as I think is known, you have an increased hydrocarbon emission. I think it should be borne in mind that spark plugs misfire for a variety of reasons - from old age because the gaps get big from oil fouling, from cracked insulators and from faulty high tension leads. They also can foul as the result of a deposit accumulating on the insulator. However, when the plugs misfire because of the first reasons I mentioned, the gap or the oil fouling, they misfire most of the time - they are misfiring at idle, they are misfiring at light acceleration and they are misfiring at cruise. The mechanism which we have pretty thoroughly studied as the deposit fouling of plugs is one which pertains largely to the larger engines of high output which when around town are pretty well loafing much of the time in traffic, and in fact they are even loafing at 55 and 60 miles an hour as far as temperatures within the combustion chamber are concerned. The deposits, some deposit

is built up on the insulators under these conditions then when the vehicle is driven hard, such as accelerations or very high speed driving, say on a Las Vegas run, where you can get up in the 80's and plus, these deposits get pretty hot as does the rest of the engine, and then they have a tendency to reduce in electrical resistivity and misfire will occur under these high temperature conditions. Our feeling is that these high temperature misfire problems occur primarily in areas where the air pollution contribution of the automobile is not at its greatest. The misfiring that occurs from the other reasons I mentioned, oil fouling, any of the others, is a reasonably continuous thing and does occur possibly in any form of driving.

CHAIRMAN THELIN: I don't think there are any questions, and being none, thank you.

MR. HESSELBERG: May I introduce Dr. Kehoe?

CHAIRMAN THELIN: I think he is being called next. Do you want to stay up here while he testifies?

MR. HESSELBERG: No, no, not at all.

CHAIRMAN THELIN: Dr. Kehoe, will you come forward? Dr. Kehoe is also appearing as a representative of the Ethyl Corporation here today. Will you start your testimony by stating your name and we also wish you to qualify yourself.

DR. KEHOE: I am Robert A. Kehoe, M.D. of the College of Medicine of the University of Cincinnati. I am the professor and head of the Department of Preventive Medicine and Industrial Health, in the Medical College in the University of Cincinnati.

I shall speak, Mr. Chairman, only on the subject of lead. This is a field of experimental work in the clinic of

medicine in which I have been engaged for a good many years and my familiarity of the other aspects of this problem is somewhat diluted, but in this area we have worked for many years.

In order to restrict this to a limited account of a body of experimental work that extends over a period of more than 30 years, I will be very careful to adhere to text, because if I get away from it I am afraid that I may try your patience.

It is the purpose of this necessarily brief statement to present the salient facts concerning the hygienic aspects of the distribution and use of gasoline containing the alkyl compounds of lead introduced in formulations of anti-knock compounds. There appears to be an impression abroad that little information is available on this subject, especially as to certain items of information that are crucial in relation to the safety of the public. The fact is, however, that no hygienic problem in the field of urban air pollution has been investigated so intensively of such a prolonged period of time and with such definitive results. I might point out there, lest there should appear to be a contradiction in this statement over previous testimony, that the evidence which I shall present and which justifies this statement does for all practical purposes come out of our own laboratories. This represents one group that has been concerned in this problem for a good many years, and there is a feeling among scientists as there is among public health officials, that this work requires the confirmation of other investigators. This confirmation is coming out of present work that is being done by the United States Public Service and by your State Department of Health,

and concerning the fact that this will be confirmation rather than a demonstration of error, I can speak with some confidence as a result of some years of working in this field.

This is not to claim that there are no significant voids in present information, or that all of the answers are at hand. Nevertheless it is clear that this specific problem, or set of problems, has been brought to such a point of understanding in relation to the public health that to remove it from the realm of urgency and to consign it into that group of hygienic problems on which a watchful eye must be kept, that is for the future. A round measure of assurance for the future may also be derived from the fact that methods of surveillance have been developed over the years of investigation which if it is not certain they are the last word are characterized by a high degree of technical precision in physiological relevance.

The investigative work in relation to the potential hazard of air borne lead from the combustion of leaded gasoline in the internal combustion engines began in 1923 in the United States Bureau of Mines experimental station. Time will not suffice here to trace all the contributions or to refer to all of the publications from various sources, but the search for pertinent information has continued in one direction or another to the present time and at an accelerated pace in gathering basic physiological information since 1937. The bulk of the investigative work has been carried out in the Kettering Laboratory and its predecessor in the Medical College of the University of Cincinnati since 1925, under the financial sponsorship of the manufacturers and distributors of anti-knock

compounds in the United States.

This statement will refer for the most part by way of documentation to the publications of the Kettering Laboratory and scientific and professional journals, to certain reports of the laboratory which have limited distribution, and also to unpublished data of which unfortunately for present purposes there are large numbers. Some of the unpublished information has been abstracted and can be provided in that form while a monograph containing much of the background information is now in press and will appear within a few weeks. This happens to be the result of a special effort to gather together in brief form a summarization of many years of experimental work for a series of lectures that were given abroad last spring. It is unfortunate that this is not available, but it will be in a matter of a few weeks. Certain aspects of the use of tetramethyl lead and other relatively volatile lead alkyls.

Aside from other matters which will be dealt with in some detail later, some concern exists in the minds of public health officials and certain other people as to the potential hazard which might be associated with the use of the more volatile lead alkyls, especially tetramethyl lead, which is the most volatile of these compounds in use. This concern has expressed itself in queries concerning the qualities of the vapors of these compounds which may appear in the general atmosphere of cities in which there is extensive use of gasoline containing these compounds. This proposed legislation which would exclude the use of any compound of lead other than tetraethyl lead in motor gasoline may or may not have been

based on this concern. In any case it seems advisable to examine the facts which are now available with respect to this matter.

The question at issue here is one which was presented to members of the staff of the Kettering Laboratory who bore the responsibility of advising the industries involved in the matter relating to industrial and public health. It should be pointed out that any additional increment of organic lead in the atmosphere which might attend the use of these compounds instead of, or along with, tetraethyl lead would reach its maximum, for reasons which will appear later in the broader discussion of the extent to which tetraethyl lead is vaporized into the atmosphere under similar conditions, not in the areas of dense vehicular traffic, but at sites in which the vapors of gasoline have the greatest access to the atmosphere; that is, at gasoline refineries, storage terminals, and gasoline service stations where gasoline is being moved from one container to another without being completely enclosed, and garages should be mentioned, storage and repair garages, repair garages in particular should be mentioned in this relationship.

Prior to the commercial introduction of gasoline containing tetramethyl lead or other lead alkyls more volatile than tetraethyl lead, this question was investigated and an installation involving the practical use of such gasoline under conditions which we produced and intensified somewhat those which would arise in ordinary commercial operation. The results of this investigation of which I have copies and I can supply the committee, were such as to demonstrate that the potential hazard associated with the substitution of tetramethyl lead for

tetraethyl lead was in entirely insignificant proportions within the limits of time occupied by this investigation. Moreover, the data obtained by the determinations of lead in the atmosphere of the installation under various operating conditions, and by the analyses for lead of the urine and blood of the operating personnel, were such as to indicate that there was little likelihood of a significant degree of absorption of lead by the exposed personnel even after a long period of employment. Nevertheless, since May of 1961 when gasoline containing tetramethyl lead was introduced into use in California and certain contiguous areas, the atmospheric conditions with respect to the concentration of organic and inorganic lead at strategic sites in relation to the commercial operations have been under periodic analytical surveillance. In addition, the representative groups of operating personnel were examined before and after approximately sixteen months of exposure to these conditions, and determinations of the lead content of their urine and blood were made at quarterly intervals. By such means, information has been obtained over a period of time sufficient to delineate both the nature and effects of the environmental conditions under investigation with respect to lead. There is undoubtedly a measurable increase in the concentrations of organic lead in the atmosphere in the immediate proximity to the point that which gasoline containing tetramethyl lead is flowing from one open container to another. For example, very near the tank of an automobile which is being filled from a service station tank by means of a pump.

The low concentrations of organic lead in the atmosphere

at such sites are so diluted by currents of air as to diminish greatly and rapidly in the air at samplings some feet away from the filling nozzle. It is possible only fleetingly and in minute traces to detect organic lead in the atmosphere of the general areas in which men carry on their daily work. And may I say at this point, that there are a lot of good methods for the determination of these organic leads in the air, of the organic lead compounds.

After as long as 16 months of such work, these men failed to yield any evidence of a measurable degree of occupational absorption of lead. And I might say in relation to the exposure to lead which results in absorption from the occupation, if it doesn't show up in six months it is not very likely to show up ever.

As to the organic lead introduced into the atmosphere by way of the exhaust system of automobiles in which gasoline containing lighter lead alkyls, including tetramethyl lead is used, no change in the quality or the quantity of the lead discharged from the exhaust pipe is to be expected, as compared to a situation in which the fuel contains tetraethyl lead, so long as the lead content of the fuel is equivalent.

On the results of the field investigation referred to above and from a consideration of the nature of the combustion products of the alkyl compounds of lead which are used in motor gasolines, the conclusion is reached that the facts which have been obtained over a long period of time in the investigation of the hygienic significance of use of tetraethyl lead in motor gasolines in relation to the public health, are applicable

in every way to the entire spectrum of alkyl compounds of lead now in use. Attention may be directed, therefore, in somewhat greater detail to certain relevant aspects of the general subject, after an examination of current commercial practices. The Use of the Alkyl Compounds of Lead in Gasoline and Their Fate in the Engine and Exhaust Systems of Automobiles. I think, Mr. Chairman, I can save your time and mine by passing over that since this is documentary information. I will just say this one thing, the maximum concentration of tetramethyl lead in current use is 2.06 milliliters per gallon; this being the concentration of this compound which corresponds in its content of metallic lead with 3 milliileters of tetraethyl. These compounds of lead are burned with the gasoline in the engine and their combustion products products in the exhaust gas as inorganic compounds of lead, chiefly the chlorobromide, but also as sulphate, carbonate, phosphate, etc., the latter being limited in quantity, varying with the presence and the concentration in the exhaust gas of these and other anions. Only minute amounts of lead alkyls in the absolute sense escape combustion, and therefore only minute amounts are discharged from the combustion system into the atmosphere. Indeed these qualities are so minute as to evade even qualitative detection in the general atmosphere of urban areas, despite the high sensitivity of current methods of analysis.

Only a portion, ranging from 25% upward to as much perhaps as 75%, probably closer to 50% on the average, of the lead which enters the engine in the fuel is discharged from the tail pipe in the automobile under the varying conditions

of city driving. But this is difficult to ascertain in a reliable or representative manner, that is the actual percentage; it varies with the methods of driving, the nature of the streets, etc. Of the lead which condenses out in the exhaust system of the engine at low speeds of operation, much is discharged at some later time of accelerated operation in flakes and chunks too large to become airborne.

Lead in the Atmosphere of American Cities. The concentration of lead in the atmosphere of American cities varies from city to city, from one area to another in any one city, and from time to time during the day, week, month or year, according to the activities and patterns of activities of city life, according to the weather and according to topography. In Cincinnati where information about this matter has been obtained over a comparatively long period of time, form the 1940's on, I may say, the concentrations range from 1 microgram to somewhat more than 6 micrograms per cubic meter of air, increasing as one goes from rural zones to suburban areas, and thence to business and industrial areas. The values are lower in warm weather rather than cold; the highest results are found in the industrial areas of the city where there are industrial operations that give out lead from their stacks.

Significant differences have also been found at individual sampling sites along urban arterial highways in correlation with the varying density of traffic at different times during the day. It is of some importance to note there has been a downward trend in the concentrations of lead in the atmosphere in Cincinnati over a period of years since the middle

forties, in association with successful efforts in the abatement of coal smoke and fly ash as well as changes in housing and traffic patterns, this despite the progressive increase in general motor traffic. There is evidence at the present time that would suggest that we have had as much, if not more, lead from the burning of coal in Cincinnati than we have from the burning of gasoline; coal containing roughly, 10, 15, 20 parts per million of lead and coming out as finely divided combustion products and fly ash.

Surveys have been made by ourselves and others in certain eastern and middle-western cities and in Pasadena and Los Angeles. The data of these investigations while less comprehensive are in general harmony with the observations made in Cincinnati, certain deviations being apparent in the form of relatively low average results and relatively high average results in others. In the latter category is Los Angeles; although it is unlikely that Los Angeles is unique in this regard among cities in the United States. Reference has been made previously to Philadelphia - I think it is fair to say that the observations we have in Philadelphia and Los Angeles are both too sparse to give us an appropriate basis for comparison, but both of them appear to be high, as compared, for example, to Cincinnati.

It is important to recognize the fact that the sampling and analysis of cities generally, or of any city in particular, with respect to lead must be carried out widely and systematically under all kinds of conditions in order to provide comprehensive information. A composite picture with respect to any

one of the several sources of lead in the atmosphere, as we shall indicate later, is by no means simple and therefore, assumptions made from scattered and sporadic data will lack validity.

Additional determinations of lead in the atmosphere in certain cities are being made currently by the United States Public Health Service by state and county agencies in California, as you know, and by ourselves. Consultation in collaboration in these efforts should provide insurance that the results obtained in Philadelphia, Cincinnati and Los Angeles will be comparable in their accuracy and significance. Such information will need to be expanded to include a larger number of cities, a wider variety of conditions and more prolonged time if the situation is to be depicted fully and if a satisfactory basis for recognition of future trends is to be established. Meanwhile, the significance of the facts now available may be examined.

The Sources of Lead in Urban Atmosphere. It appears to have been assumed by many persons that the largest portion of lead in the atmosphere of cities is derived from the combustion of leaded fuels. There were a few recorded determinations prior to the introduction of such gasoline into general use in the United States in 1926 and accordingly there are no satisfactory data for comparison. Moreover, prior to 1926, and indeed prior to 1938, methods of sampling analysis had not been developed satisfactorily. Current investigations have failed to determine the relative magnitude of the contributions made by the combustion of coal, wood and other vegetation, by the stacks and burning grounds of industry, and by the dispersion into the air of dust from the surface of the earth. This is not to suggest that it

makes any great difference to the public what the source is if it should happen to be in dangerous quantities. I was just pointing to the fact that there are sources, and this is important in terms of control, because unless you can control the various sources, you haven't control.

Those who have had the longest and widest experience in exploring this matter are the least likely to venture any estimates as to the relative importance of the various sources. Suffice it to say at this point that the occurrence of lead in the atmosphere breathed by man is no new phenomenon, and it would suffice also to suggest that there have been many ups and downs in the magnitude of this source of human exposure to lead in various places within historic time.

The General Order of Magnitude. The available information from all sources makes it quite clear that the lead content of the atmosphere of representative American cities is of a generally low order of magnitude. The results of sampling and analysis in the air vary with a number of factors that have been recognized and probably with others that are not now evident. A few widely aberrant results have been obtained from place to place and from time to time and undue significance has been attached to some of these. Such unusually high values may be the result of the concurrence of unusual conditions, but it is more likely that they were obtained in error through some fault in one or more of the procedures of sampling or analysis. If for example in the area is a breeze that picks up some stuff from the street and a chunk of this happens to get into the sampling analyses, this may give rise to a very high result, one such chunk being

much more lead than would be found in quite a lot of very finely divided material. Of much greater importance, both statistically and physiologically is the prevalence of results of a low order of magnitude on the average results over appreciable periods of time. The average of current determinations in Cincinnati falls between one and two micrograms per cubic meters of air. Available data which tend to represent the more severe conditions associated with atmospheric inversions rather than average conditions, suggest the corresponding level in Los Angeles is appreciably higher than that of Cincinnati - perhaps by as much as three-fold or four-fold. Results which came to your attention this morning would indicate that this is only of the order of magnitude of two-fold. I can't vouch for that however. I am not in a position to demonstrate this point. However, average values expressed in such minute units as micrograms per cubic meter and arrived at on less than comprehensive data, leave probabilities for error which reduce the difference between one, two, four and six, if not to insignificance when examined either mathematically or physiologically.

The foregoing comments on the uncertainty which attaches to the actual concentrations - that is the effectively prevalent concentrations - of lead in the air of cities, might be considered double-edged in that the spectre of doubt may create apprehension lest the concentration should be actually appreciably higher than those now regarded as prevalent. There is, however, other evidence on which to judge this case. The hygienic significance of lead in the air may be, and in the long run must be, interpreted on the basis of the physiological, not the toxicological,

effects of the absorption of lead on the population subjected to exposure thereto. Specifically, the contributions made by lead in the overall absorption of lead by representative persons in the population in California or elsewhere can be estimated with reasonable precision through the use of the methods and on the background of the prolonged and elaborate physiological experiments on human subjects, in combination with field investigations made during the past twenty years or more. Certain of the more important facts may be extracted from the details and summarized for present purposes. I might in connection with the presence of lead in the air make reference to one other point which I am sure is of considerable importance, and of considerable interest in the Los Angeles area, namely the possibility of the effects of finely divided lead in the atmosphere as a point of agglutination for smog. Some tests made by the Midwest Research Institute on this particular point, appear to have eliminated the influence of lead in this particular respect. It seems not to be one of the important aspects of this problem, and whereas this is not strictly within my realm as being physiological, it is nevertheless important in connection with the formation of smog, which we all recognize as of hygienic significance.

Lead in the Environment of the American Population from Excretion and Accumulation. The natural environment of mankind is such that lead is taken into the body in virtually all human food and beverages and in the required air. Man living in a state of nature in certain parts of the world take in somewhat more than a third and somewhat less than half as much lead as

does the average man in the United States. The many uses to which lead is put in our modern industrial society, one of which is involved in the present discussion, have increased the amount with which this average man comes in contact with the result that more lead enters into the metabolic processes of his body. The quantities are small but not insignificant since they are measurable. The food consumed by an adult in the United States contains lead in amounts which range from less than a tenth of a milligram to four milligrams, occasionally more, per day. The higher and lower values mentioned occur infrequently, the larger proportion of the daily quantities grouping themselves regularly and closely around the mean value of approximately one-third of a milligram per day. I am not talking about micrograms, but milligrams. This is 330 micrograms per day. This is the average of what you and I who eat wherever we may choose take in daily in our food and drink.

The quantities taken in daily with the inspired air are not so well defined since they must always be the calculated products of the average concentration of lead in a volumetric unit of the air breathed in by an individual during each period of 24 hours, multiplied by the total number of the volumetric units of such air breathed in during that period. Just in order not to get obscured by this mouthful of words, if you estimate the content of the air in terms of micrograms per cubic meter and then consider the number of cubic meters of air that pass through our bodies per day in the course of the respiratory cycle, you have the basis for this calculation, which is quite simple. On this basis, these qualities range between 15 and 100 micrograms

per day, even the higher value here being less than a third of what we take in in our food and drink, and as in the case of the intake in food, the average in any situation is probably much nearer the low value than the high, for reasons which will appear later.

The maximum quantities of lead absorbed into the body from that taken into the alimentary and respiratory tracts of the average man may be determined with approximate accuracy on the experimental evidence which shows that somewhat less than 10 per cent of that ingested, that is to say swallowed, and somewhat less than 50 per cent of that inhaled, are absorbed. Such calculations indicate that some 30 micrograms are absorbed daily from the alimentary tract while some quantity between seven and fifty micrograms per day may be absorbed from the respiratory tract.

Evidence obtained by corresponding means has demonstrated that the quantities of lead ejected from the body daily by the average man are substantially equivalent, statistically and physiologically, to those taken in. Thus the lead which is evacuated with the feces daily correlates closely with that in the food and beverages extending over the same range and yielding the same average within the limits of the individual's variability and experimental error. That which is excreted in in the urine ranges from somewhat less than 10 micrograms to about 80 micrograms per day and averages approximately 30 micrograms per day. The total output of lead in feces and urine over a period of months usually exceeds slightly the intake in the food and beverages thereby disclosing indirectly

the approximate order of magnitude of that absorbed in the respiratory tract, which in the case of persons investigated in Cincinnati is of the approximate order of 20 micrograms per day.

From these experiments and field surveys, the data of which are assembled in representative form in a monograph which is in press but are less readily available otherwise in published articles and in reports of the Kettering Laboratory, facts emerged which demonstrate clearly that under the conditions that exist in the United States at the present time, the quantity of lead which is being absorbed daily by the average adult citizen who is not subjected to occupational or otherwise unusual types of exposure to lead, is balanced for all practical purposes by the excretion of a corresponding quantity of lead. The manipulative error of these experiments is such, to be sure that the apparent balance between intake and output may not be precise and therefore there may be some slight progressive accumulation. If this should be the case, such accumulation is indeed slight and physiologically insignificant in terms of present physiological and clinical evidence.

The Absorption and Excretion of Lead Under "Abnormal" Conditions of Exposure. One could not support the foregoing interpretation of the findings obtained from experimental subjects in the laboratory and from various groups of persons in the community at large were it not for additional types of evidence. The most important features of such evidence relates to the demonstrable physiological responses of experimental subjects and occupational groups of persons to the absorption of quantities of lead beyond the range of those which are

encountered in ordinary life. The rate of the urinary excretion of lead is influenced significantly by a number of factors that under appropriate conditions, that is to say under controlled conditions in which you can tell what is going on, varies with the current rate of absorption of lead. The concentration of lead in the blood, also under appropriate conditions, varies to some extent with the current rate of the absorption of lead, but is relatively slow in reflecting this rate unless the current rate of absorption is very rapid. Instead it best represents the approximate state of the body generally with reference to its overall burden of lead. This may require a little explanation. If one considers that the distribution of lead in the body in accordance with a certain pattern, put some of it in the skeleton, put some of it in the other tissues, and some of it in the blood, the blood, which is easy to get at and to analyze, gives us a fairly good index of the proper physiological conditions of the body burden of lead. This is one of the most important aspects of this problem. Accordingly, if the current rate of lead absorption is sufficiently high as compared to the usual or normal rate, there is accumulation of lead in the tissues of the body, including the blood. And the concentration of lead in the blood mounts slowly to a point at which with due regard to the complexity of the processes whereby lead is distributed within the tissues under various conditions, it is indicative of the approximate quantity accumulated in the entire body.

Under the conditions of occupational exposure to lead it has been possible to develop criteria for the safety of

workmen, individually and collectively, in terms of the rate of the urinary excretion of lead on the one hand, and the concentration of lead in the blood on the other. Stated briefly and without the necessary qualification with respect to the type and duration of exposure to lead and the methods of sampling an analysis, the threshold values indicative of the dividing line between safe and dangerous degrees of occupational absorption of lead are approximately the concentration of 150 micrograms (0.15 milligrams) per liter in the urine, and that of 80 micrograms - Mr. Maga this morning gave the figure of 75, I have given the figure here of 80 for reasons which I am perfectly willing to discuss - per 100 grams of whole blood. If these threshold values are in error, (the urinary concentration will be so regarded by some industrial physicians) they err on the low side, being somewhat more severe than they might be in relation to industrial requirements. This is a matter of professional viewpoint with respect to the proper margin of safety in standards of industrial hygiene.

There are no corresponding criteria which are strictly applicable to the problem of the essentially continuous exposure to lead on the part of persons in the general population. The finding of lead in the urine and blood of such persons in concentrations in excess of threshold values would, of course, demonstrate the existence of actual hazards, but the failure to find such results in any part of the general population at any one time provides no certainty that no hazard exists. The obstacle here lies in the fact that the uninterrupted absorption at a sufficient elevated rate above the prevalent or normal rate

results in a progressive rate of accumulation of lead in the body. The intermittency of occupational exposure to lead represented by approximately 40 out of 168 hours in each week, enables the exposed person to arrive at metabolic equilibrium with their occupational environment, whereas such an equilibrium either fails to appear or is reached after a long period of time under the conditions of continuous exposure. On physiological grounds, therefore, in order to appraise the significance of continuous exposure to lead in relation to accumulation, that is exposure to lead in the air, plus what's in the food, such as you would have here in Los Angeles or any other city in the United States, it is necessary to maintain observations over periods sufficiently prolonged to demonstrate whether or not there has been a slight progressive increase in the quantity of lead in the bodies of representative persons. The present alternative to the wholesale analysis of such bodies, that is the whole bodies of people as opportunity is afforded in search of direct evidence in this direction, is the periodic survey of the rate of excretion of lead in the urine and the concentration of lead in the blood of representative groups of persons in the general population. On the basis of such information gathered at intervals over the entire period since the development of adequate analytic methods, running back to 1937-1938, the well documented fact is that no evidence has been found of a significant change in the lead metabolism of persons in the general population who are free of occupation or other unusual opportunities for exposure to lead. Moreover, there is no indication that groups of persons in Los Angeles are absorbing lead at a rate which is significantly

greater than that of corresponding groups in Cincinnati. This matter is being further and currently investigated by the Department of Public Health of the State of California in collaboration with the U. S. Public Health Service, and we need more information on this point, which is coming in.

Data pertinent to this locale, however, now available in a periodic survey referred to previously, which is documented here by a report which has involved a comparatively small but representative group of men who work daily out of doors in areas of comparatively heavy motor traffic, that is in Los Angeles, the analytical findings with respect to lead in the urine and blood cannot be differentiated from those obtained on a much larger scale in Cincinnati and vicinity in 1956-1957. Moreover, these repeat the pattern of normal findings which have characterized the American scene for the last twenty odd years.

Certain General Observations and Conclusions. Aside from the question of the reliability and accuracy of the experimental work outlined briefly herein, and I may say that this experimental work is being checked as to these conclusions at the present time by the Public Health Service and by your people here in California, and if I may express an opinion I might say that one of the greatest advantages in this work that is going on at the present time either will demonstrate that we are right or that we are wrong; this is perhaps the biggest piece of evidence that will be obtained by this information.

Aside from the question of reliability and accuracy of the experimental work outlined briefly herein, one feature of this outcome that is somewhat disturbing to some of those who

have had professional responsibility for the safety of some segment of the population of this or other countries is its quality of negativity. This, by the way, is a thing which has disturbed the British, the French and the Swiss and there have been investigations in each one of these countries one of which in Switzerland has been reported as of the past year. No one, and strangely enough this includes men with sound scientific training is impressed by negative findings, despite the fact that the public health must be described in practice in such terms, and that safety must correspondingly be defined of the absence of hazards, when a satisfactory search for hazard has been undertaken and carried out. We are seeking, and I am speaking of ourselves, we are seeking in this instance not a disability nor a disease, but a threat. No such threat has been found although the methods for detecting it has been forged and sharpened to a point of sensitivity in detecting not the occurrence but the threat of occupational lead poisoning. The methods may, in time, and by ingenuity be refined still further. In terms of present information, however, which has been sought systematically and patiently,the fact is clear. No present hazard to the public health is represented by the lead dispersed in the air in association with the distribution and use of leaded gasolines. Moreover, the methods of investigation available at present are such that a sudden or gradually progressive increase in the lead content of the atmosphere or for that matter in the intake and absorption of lead from any and all sources can be detected before it reaches dangerous proportions.

In addition to this safeguard, it should be possible

before long to develop criteria for the promulgation of reasonable standards of air quality with respect to lead content which will take into account the physical and physiological factors that influence the respirability and the absorbability of the compounds of lead that occur commonly in the atmosphere. Truly, this is a matter which is complex in itself and one which must be balanced against the other sources of lead absorption if it is to develop. A better procedure in relation to public safety would be that of making observations from time to time on representative groups in the population by methods which will indicate the sources and the order of magnitude of any significant changes in exposure of the public to lead and provide intelligent basis for hygienic control.

Gentlemen, I have here, but unfortunately, not many, certain documents to go around. I didn't realize that these were going to be required and I have only two sets. These, I am very happy to provide and I can provide others, if you require them, but the vicissitudes of airplane travel project to me the advisability of not bringing quite so much stuff along.

CHAIRMAN THELIN: Thank you, doctor. As long as we have one for our files, I think that will be sufficient. Does that conclude your presentation?

DR. KEHOE: That is all I have to say, Mr. Chairman.

CHAIRMAN THELIN: One question. Testing the lead compounds in the atmosphere, were you here this morning when we had some discussion about that?

DR. KEHOE: Yes, I was.

CHAIRMAN THELIN: I wonder if you could give us your

opinion on that as to the accuracy of the methods that are used. Are you using something different than they did back, I believe it was, in 1926, as the time mentioned?

DR. KEHOE: We've had methods now for the quantitative analysis of organic lead in the atmosphere, oh, for I should think now, about ten years or so. Prior to that time, we had to have quite large quantities in order to get enough there to analyze. However, an instrument has been developed that enables us to collect air through a system that would participate out the inorganic lead in an iodine solution and there are methods of analysis which do this job pretty well. They can detect concentrations in the order of one, two and three micrograms of lead in the air, except that at this point you have to take a fairly good sized sample. The size of the sample balanced by the sensitivity of the method determines whether or not you are going to find lead in the air. Now, the fact of the matter is that if you go into the Los Angeles atmosphere, the Cincinnati atmosphere, the New York atmosphere and test for the presence of organic lead you will not find any. The quantities there are just simply too small to be detected by our methods of analysis because we have to take so large a sample in order to find anything at all that we run into an experimental error from this cause alone.

CHAIRMAN THELIN: Did you say inorganic?

DR. KEHOE: Organic.

CHAIRMAN THELIN: Organic.

DR. KEHOE: Now at a filling station or at a loading rack where gasoline is being spilled or where it is being emptied

from one container to another, if you get near the point at which this liquid is being handled, you can find gasoline vapor and you can also find organic lead. If you get 20 feet away from this, you can still detect it qualitatively but there is some question about the accuracy of the analysis because you are dealing there with such small quantities. As you get still farther away, you will lose the ability to detect this by our present method, in spite of their rather high sensitivity.

CHAIRMAN THELIN: Any questions from members of the Committee?

ASSEMBLYMAN RUMFORD: I have.

CHAIRMAN THELIN: Mr. Rumford has some.

ASSEMBLYMAN RUMFORD: Dr. Kehoe, would you tell us what the relationship, if any, the Kettering Laboratory has to the gasoline industry?

DR. KEHOE: Yes. The Kettering Laboratory was founded in 1930 by a gift of funds from several industries who had come to us for assistance in the College of Medicine. I was in the Physiology Department of the Medical School when this particular problem arose and I was brought into it by virtue of trouble within the industry. Having gotten into this and having turned my attention in this direction I never got back out of it. In the meantime, the Kettering Laboratory has been developed into an institute for the study of occupational diseases and is largely financed by industrial organizations who come to us with problems. Our patients, by and large, are not people but industries that are in trouble or think they are going to be in trouble. So that we have been engaged now for something like

thirty years in the systematic investigation of the number of the major problems of industrial health in this country. These have run us into some problems that had to do with public health since industrial health runs over into the field of public health. But to answer your question, this is a laboratory which is operated under the policies, under the direction of the Board of Directors and the administrative officers of the University who enter into all the contractual relationships and I, as the Director of this laboratory, am the agent of the University, our difference being that our funds come from the people for whom we work rather than from the public purse.

ASSEMBLYMAN RUMFORD: Some reference was made to Public Health Bulletins that were published in 1926, this morning, and I am wondering if these results are outdated or if there is any agreement between the studies that you have and some of the statements made with reference to Bulletin Number 163.

DR. KEHOE: I think it is quite fair to say that this investigation of the Public Health Service, a concurrent investigation made by ourselves at about the same time, several investigations that came periodically after that time are all outmoded in terms of the qualitative data. The analytical methods available at the time were not such that we can get results that are comparable, so that if you - the results are correct in principle, but they are incorrect in the specific detail that they are relatively inactive. If you want to get comparable results that you can put side by side, they must come after, say, about 1937 or 1938.

ASSEMBLYMAN RUMFORD: Your studies, then, I assume, have

been made on animals as experimental sources?

DR. KEHOE: For the purpose, yes, of determining the toxicity of specific compounds, we have investigated tetraethyl lead, tetramethyl lead and a great variety of other chemicals by means of animal experimentation, for the purpose of getting the information that can be carried over into industry and used clinically for the protection of people.

ASSEMBLYMAN RUMFORD: Generally, the Federal government has accepted the results of your experiments, sir, as being authentic and -

DR. KEHOE: I think you ought to get their testimony on that, but I think I can assure you that this is the case.

ASSEMBLYMAN RUMFORD: Will they continue to refer problems to you?

DR. KEHOE: They do, yes, indeed.

ASSEMBLYMAN RUMFORD: Must have some confidence in your methods.

DR. KEHOE: I believe they do.

ASSEMBLYMAN RUMFORD: You are very specific in that you state that no present hazard to the public health is represented by lead dispersed in the air in association with the distribution and use of leaded gasoline.

DR. KEHOE: That's right.

ASSEMBLYMAN RUMFORD: From the results of your testimony, I don't think there is any question about your thinking in this respect.

DR. KEHOE: No, there is no question in my mind in this. This is a problem that I started out to solve as early as 1925,

we have been on the trail of it ever since and I have no doubt about what the situation is at the present time. I don't know what it will be ten years from now, I'm talking about today.

ASSEMBLYMAN RUMFORD: I see, thank you.

CHAIRMAN THELIN: Mr. Brown, do you have a question?

ASSEMBLYMAN BROWN: Dr. Kehoe, I didn't see any place in your testimony a statement as to the mean or average values of lead in the blood based upon your samplings of various areas, Cincinnati or others. Do you happen to recall that figure?

DR. KEHOE: Yes, I can give you the figures and they not only apply to Cincinnati, but they apply to other areas in the United States. The kind of results that you will obtain when you go out into the population and examine normal people who have been queried with respect to whether they have occupational or other kind of exposure, the kind of results that you obtain will, in the blood, range from slightly under .01, that is to say 10 micrograms per 100 grams, up to values as high as .05, that is 50 micrograms. Now you will occasionally and in the same group of individuals, you will occasionally get a result as high as 60 micrograms, this being, in our interpretation, an analytical result that is a little bit off color. We have a little bit more experimental error than we should have. Bear in mind here that we are dealing with micrograms and that this is one of the most precise microchemical determinationsthat there is in medicine. The error is in the order of magnitude of plus or minus 10 micrograms.

ASSEMBLYMAN BROWN: Is there an average figure? You've given us a range here.

DR. KEHOE: Yes. The average figure comes right out

regularly in Los Angeles, in Cincinnati and New York, in Philadelphia, in our data, right around .03 - 30 micrograms. The results found by the Public Health Service generally are slightly lower than this. They are nearly 10% lower than we are in all their determinations.

ASSEMBLYMAN BROWN: So that as far as your observations are concerned, the average amount of blood lead is essentially the same every place it is measured?

DR. KEHOE: We have made more observations than anybody else in the world, of that I can assure you, and this figure has not changed materially in nearly twenty years.

ASSEMBLYMAN BROWN: Your testimony also stated that - let me develop a couple of points here - but in general the lead which is absorbed as a result of breathing, tends to stay with the body considerably more to a larger percentage than that which is ingested or eaten?

DR. KEHOE: I wouldn't - may I just correct that in one respect. This is not a question of staying with the body. It is a question of being absorbed. The alimentary tract is a sort of an open tube. You take in things at one end and evacuate it at the other. In the process, absorption occurs, and the absorption of lead is not any too good and under the ordinary conditions, this absorption will be somewhere between five and ten percent of what is actually swallowed. Unless this is a chunk, such as a lead bullet, in which case you absorb practically nothing. In the case of the respiratory tract, on the other hand, you have here a system that has difficulty emptying itself if, indeed materials are deposited in it. A degree of emptying takes

place by virtue of ciliary action, coughing and this sort of thing, so that there is a degree of clearance, but what is actually deposited in the lung tissue itself, which, when you are dealing with small particles, is in the order of magnitude of 35 to 50%. That which is deposited there and is soluble is absorbed almost immediately and all that remains under these circumstances that is soluable will be absorbed. This is almost equivalent to sticking it into the blood stream.

ASSEMBLYMAN BROWN: Yes. It seems to me that what you are saying is that a larger percent of the lead which is breathed is absorbed than that which is eaten.

DR. KEHOE: Under equivalent conditions with reference to solubility and so forth, yes, this is distinctly true.

ASSEMBLYMAN BROWN: Your testimony concurred with that previous witness that the level of lead in the atmosphere in Los Angeles is substantially higher than it is in Cincinnati or the average of other cities in the United States. Your figure was, well, two to four or six times as much, is that right?

DR. KEHOE: No. Two to perhaps four times as much, depending on where you are centered. I was very cautious, however, if you will remember, in saying that in connection with these, such observations in which we have problems of analysis we have more particularly problems of sampling to get something that is characteristic. The difference between two and four here. This is something that causes you to elevate your eyebrows. Statistically there is a difference, but in fact there is not much.

ASSEMBLYMAN BROWN: I'm just stating this to confirm

the testimony that we had from the Department of Public Health which showed several samples that run from, well, in one case 3.6 for Los Angeles compared with 2 for Cincinnati which is about twice as much, and another study showed 6.6 which I presume would compare the two and Cincinnati which is about 3.3.

DR. KEHOE: Well, our figures for Los Angeles in connection with the study that was carried out here during a period of inversion, gave us an average figure of about 6.7. Corresponding average in Cincinnati is a little under 2.

ASSEMBLYMAN BROWN: Yes. That would be your range of 4 then.

DR. KEHOE: But the question here is, what is the average throughout the year? And this I must confess I don't know.

ASSEMBLYMAN BROWN: No one would know. The point that I'm leading up to is this, that under these circumstances with this considerably greater concentration in Los Angeles which is inhaled and gets into the respiratory system, how do you account for the fact that there is no observable trace of this in terms of a difference in your mean blood lead level.

DR. KEHOE: I think this can be accounted for. And please don't hold me strictly accountable for my interpretation, because this is something in which I have to go on the basis of my judgment. What I would say is probably the reason that the amount which we actually absorb from the lungs is not as great as the calculated sum which we've made. Now I can calculate for you how much lead you will take into the body in case you stay in an atmosphere that has about 6

micrograms of lead in it for a 24 hour period. But I can't tell you what you will absorb when you live in one place, work another, are indoors, outdoors, go to sleep at night and your respiration drops low. I just can't take all those imponderables into effect and tell you how much you will absorb. What I am saying is this, we habitually in this field look at the worst picture rather than the best. And in this instance what we are looking at when we estimate this is, I am convinced, too high.

ASSEMBLYMAN BROWN: Well, this is an obvious explanation that something is too high because if we just look at the figures it would appear that in the Los Angeles area we are taking in about three times or two to three times the amount of lead that we would be in Cincinnati or any other place, and this should show up in the blood somewhere, the blood level somehow.

DR. KEHOE: Well, the fact is though that it doesn't. So there is something wrong with our calculation, isn't there? There are several possibilities for this. I gave you the figure in Cincinnati of variations between our industrial area and our suburban areas of differences from one to six. What is this variability in Los Angeles? I don't know. We've looked at Cincinnati very carefully because we live there and it is easy to do. We have made sporadic observations in Los Angeles. So I think, sir, you are going to have to wait until a corresponding number of observations have been made in Los Angeles. And at this time I think this will probably explain the difference.

ASSEMBLYMAN BROWN: Well, some explanation seems to me to be in order because you cannot confront the figures

here without realizing that there has to be some explanation of this.

DR. KEHOE: Quite, sir. Quite. But you cannot deny physiology. You cannot absorb lead and not excrete it. If you do not excrete it you are not absorbing.

ASSEMBLYMAN BROWN: You can't have four times as much lead in the atmosphere in Los Angeles as you have in Cincinnati and not have it show up in the blood stream if your method of checking this is any degree accurate.

DR. KEHOE: Again, you must look at this from the point of view of all sources and the relative importance of each source. Now we can study individuals and have for some years in a respiratory chamber in which they are exposed to a specific amount of lead in the air. If we raise this up to 75 micrograms per ten cubic meters we get a prompt response in terms of increasing urine concentration and in terms of increasing blood level. This does not occur in the population, therefore, the corresponding condition does not exist. There is no other possibility.

ASSEMBLYMAN BROWN: When you state that the average amount of lead in the blood throughout all of your studies in terms of micrograms per hundred gram is in the order of .03, which I believe is the figure you gave.

DR. KEHOE: The mean trigger, yes.

ASSEMBLYMAN BROWN: The mean trigger, and we find that the mean in Los Angeles is in the order of .02. It causes me to have some doubts about the reliability of the procedure.

DR. KEHOE: Well, I did point out one thing which is quite true. In this type of analysis, in this type of analytical

work, you are dealing with a highly sensitive method that has an experimental, an inevitable experimental error. You have to watch every possible source of contamination to avoid occasional high results. Now, the Public Health Service in this connection, they have said to me privately, "We believe that our methods of analysis are better than yours because we are getting lower results than you do." And they do systematically.

There is another laboratory with whom we have been paralleling our work for nearly ten years. They get slightly higher results than we do. Now, this is something that occurs in the makeup of a chemical laboratory in dealing with a very highly sensitive microchemical method. I am not trying to cast reflections upon the scientific procedure because I am sure they are the best which are available to us, but I am pointing out that the results are contradictory to the gross facts which are concerned.

CHAIRMAN THELIN: Any further questions? If not, thank you very much, Dr. Kehoe.

We are now going to call some representatives of the Western Oil and Gas Association. First one will be Mr. Harry Morrison.

MR. MORRISON: Mr. Chairman, and members of the committee, my name is Harry Morrison. I am Assistant Manager of the Western Oil and Gas Association. This association through its members represents about 90% of the refining capacity in our six western states of Alaska, Arizona, California, Washington, Oregon and Nevada.

We understand that this hearing has been called for a

series of purposes involving itself in AB 2335, HR 411, and a series of questions which were subsequently made available to those who had received the first notice of the hearing.

Speaking for our Association, we would oppose AB 2335 and would speak today in opposition to the elements involved in this bill. With reference to the questions, my statement here today does not follow the questions, but will be responsive to the first four, and I will then seek to introduce Dr. Nicksic, whose comments would be responsive to questions five and six. Now I realize that the hour is late and I would, however, like to read this to you and I will read it as rapidly as I can. Some of it I will not.

CHAIRMAN THELIN: Fine, we appreciate that, I must say.

MR. MORRISON: I would like to cover here today the set of facts concerning non-metallic additives and sulfur in gasoline. The general subject raised by the resolution includes a questioning of the ratio of certain hydrocarbons to all the hydrocarbons in the gasoline. More popularly known as the effect of the olefin content or bromine number on the smog potential of gasolines. We have asked Dr. Stephen Nicksic of California Research Corporation to cover this phase.

When dealing with the subject of gasoline and its relationship with smog (now I'm on page 2 in case you would like to follow me) it often appears that a normal mistake is made by jumping into the middle of the subject and starting the process of listing the additives, their effects, their amounts, etc. This may not be fair to the listener, because the obvious question arises - why not get rid of the additives and forget

them. The answer to that is quite reasonable.

Gasoline, like other products in our modern society, is constantly being improved. It must be changed to meet the new requirements and conditions of use. This must be done at a minimum cost to the consumer as this commodity has now become a necessity.

Fifty years ago gasoline was an unblended, unsophisticated, straightforward, simple hydrocarbon mixture. Many a Model T Ford has been run right on the job at a well site from a completely unrefined product. The engines were simple, compression ratios were low, and the requirements were few.

However, the American society has required better engines and the oil industry provided the gasoline to meet its requirements. Current gasoline quality and quantity demands could not be met at a minimum cost to the consumer if present day use of additives were prohibited.

The resolution, which is the subject of your hearing today, does not specifically mention sulfur but since sulfur has come to have some notoriety both in bills introduced in the Legislature and as a producer of sulfur dioxide in the atmosphere, it is felt that your honorable subcommittee would appreciate some information on the amount of sulfur in gasoline. Some suggestions have been made in AB 2335 that the sulfur in gasoline be reduced to 1/20 of 1% by weight. That is .05%. The weighted average of the sulfur in gasolines sold in Los Angeles County, according to the latest report of the U. S. Bureau of Mines, is approximately .06% by weight. (This is also the approximate weight percent of sulfur in gasoline sold

throughout the State of California.)

So the effect of any reduction as proposed in a bill would be to reduce the sulfur from .06% to .05%. Using official data of the Los Angeles County Air Pollution Control District as a basis, this change would reduce sulfur oxides emitted to the atmosphere in Los Angeles County during the summer smog season by 3.1% (it would reduce it from 128 tons a day to 124 tons a day). During the winter, when burning of heavy fuel oil is permitted, the current emission would be reduced by only 7/10 of 1% (a reduction from 585 tons per day to 581 tons per day). Thus, the effect of the sulfur limits on gasoline imposed by AB 2335 would be insignificant.

Further sulfur reduction in gasoline would not be insignificant in its effect on gasoline costs. The capabilities of refining methods now in use have been fully exploited and further reduction of sulfur in gasoline would require the installation of expensive equipment. In our opinion, the added cost would not be justified by this unimportant reduction in emissions.

AB 2335 also proposed a reduction of sulfur in diesel fuels to 1/4 of 1% by weight. The automotive diesel fuels now contain less than 1/2 of 1% sulfur by weight. Again, based on Los Angeles County Air Pollution Control District data for diesel operations, the reduction of sulfur dioxide emissions in the area would amount to less than 1% in summer and less than 2/10 of 1% in the winter. Although such a reduction is quite insignificant in the air pollution control picture, new, and of course, costly equipment would be required to achieve the reduction.

Since you have before you a resolution concerning the relationship of fuel composition to smog, it is pertinent to inquire as to the relationship of sulfur oxides in smog. Here I refer to the statement made by Dr. John Goldsmith which was earlier put in the record for you today by Mr. Maga, in which he said that studies have shown there is apparently no relationship between sulfur dioxide and eye irritating smog.

Included with the development of any product, there is a moral responsibility to insure that its use is harmless. The oil industry is completely cognizant of that responsibility. Before any additive is blended into marketable motor fuels, it has been fully tested by the supplier or the oil industry. Such testing establishes the maximum amounts or concentrations of the additive which may be safely used. The amounts used are always below the safe limits. Constant quantative control is maintained by industry members. The majority of additives are organic materials and, as such, follow the laws of combustion. Products of combustion are primarily carbon dioxide and water, both non-toxic materials.

Additives are used to improve the qualities of motor vehicle fuels. All member companies of Western Oil and Gas Association do not use the same types of non-metallic additives. Types of additives used also vary with the grades of gasoline. I should like to present a list which is not representative of any one company but does include the types used by all of them. This list indicates the name, function, and maximum concentration of each type of additive. All concentrations are well below those that might be considered toxic.

Non-Metallic Additives in Motor Fuels

Name	Function	Maximum Concentration Used (1 ppm by Weight = .0001%)
Hydrocarbon Base Dye	Color	4 ppm
Detergents	Carburetor Cleaning	30 ppm
Amines	Anti-Oxidants) Metal) Deactivators	20 ppm
Phenols	Anti-Oxidants	20 ppm
Alcohols	Deicing Agent	75 ppm
Phosphates	Ignition Control	200 ppm
Boron	Ignition Control	40 ppm
Nitrates	Ignition Control	215 ppm
Polymer	Pour Point Depressant	17 ppm
Organic Oxide	Diesel Detergent	200 ppm

One of the effects of motor vehicle exhaust is that it is a prime contributor to our photochemical smog. The State Department of Public Health has adopted air standards on the amount of photochemical smog at which adverse effects begin to occur. The effects are eye irritation, plant damage and visibility reduction. These levels are exceeded in Los Angeles regularly. Although we are not experts in the health field, the answer seems clear that motor vehicle exhaust does constitute some hazard to the well being of the community.

In this respect, I would like to call your attention to an article in the August 27, 1961 edition of the Los Angeles

Times by Harry Nelson, the Times Medical Editor, and I quote from this article:

"The 'irrationality' of some individuals, including a few doctors, who 'exaggerate' the health hazards of smog, has been criticized sharply by one of the nation's top air pollution experts.

"'Smog is an aesthetic and economic nuisance and should be fought as such,' declares Dr. A. J. Haagen-Smit, professor of bio-organic chemistry at Cal-Tech.

"'Don't believe the stories that death in the form of smog stalks the streets of Los Angeles.'

"Dr. Haagen-Smit, the first scientist to explain the chemical interactions that cause smog formation, was interviewed during an air pollution training session at Cal-Tech last week under sponsorship of the U. S. Public Health Service.

"He said that respectable research presenting valid information that smog is harmful to persons with certain conditions is desirable and should be encouraged.

"An example of such work, he said, is that of Dr. Hurley Motley, whose laboratory at Good Samaritan Hospital has shown that patients with a lung disease, emphysema, are worse on smoggy days.

"But to draw sweeping conclusions and scare the public as a whole is to form opinion based on emotion and not on scientific evidence, he said."

And I quote from another section of the article:

"For the public to have fears that smog is causing cancer is once more to put the health implications out of

perspective, insists Dr. Haagen-Smit.

"The public might worry more justifiably about the cancer-causing chemicals they breathe while sitting around a fire on a summer camping trip or that they ingest when eating a well-done steak.

"'I don't say that smog is good for you, but I like to put things in perspective and point out that smog is far more of an economic and aesthetic nuisance than it is a health hazard,' he said."

I had hoped to take the time to read portions of affidavits and letters, which I will not do, Mr. Chairman. But I have here letters that I am going to file with you - the originals from DuPont, from the Ethyl Corporation, a telegram from the Nalco Chemical Company, providing amine formaldehyde reactions, a letter from Universal Oil Products, a letter from Eastman Chemical Products, subsidiary of Eastman Kodak - they make anti-oxidants and metal deactivators, a letter from Dr. Charles H. Hine, with reference to trichrysal phosphate, which I think you would recognize a little more better as TCP, and an affidavit from Dr. Russell S. Fisher, Associate Professor at the University of Maryland Medical School, with reference to the toxicity, or a better word is the non-toxicity of boron containing compounds. If you like, Mr. Chairman, I can refer to any of these specifically if you want to ask any questions, if not, after I have finished, I will file them with you.

CHAIRMAN THELIN: Have all of these reached the same conclusion?

MR. MORRISON: They all reach the same conclusion. The

words non-toxic, no toxicity, non-toxic at the concentrations used, non-toxic particularly with reference to their dilution after they go into the atmosphere, these are the phrases that you find throughout these statements.

CHAIRMAN THELIN: We'll accept these, then, for the committee records.

MR. MORRISON: Thank you. Now I have in this short time attempted to provide your honorable subcommittee with information which has been prepared for you by representatives of our oil industry here in Southern California covering sulfur and non-metallic additives. And as indicated earlier, we have arranged to have some of these people here to answer your questions. I am not an expert, but I have a whole team back here who can answer, I think, almost any question that you might care to propound on these points, or anything else that has arisen today that you would like to ask about. So if you have any questions concerning non-metallic additives or sulphur or anything you would like to ask at this time, I am prepared to either try to answer them myself or refer the question. Then I would like to have the privilege of introducing Dr. Nicksic.

CHAIRMAN THELIN: Mr. Morrison, I wonder if you could address yourself to this matter of one company in the east that apparently produces and sells unleaded gasoline. The question was asked earlier how they can do it and the companies out here cannot. Can you enlighten us a little more in that respect?

MR. MORRISON: The company referred to is the American Oil Company. The process of making unleaded gasoline is primarily a process of starting with a pretty good crude and

and then running the blend through the various devices in the refinery again and again and again. A word which generically is referred to as severity. The way that the American Oil Company - first of all, the American Oil Company does make unleaded gasoline, 100 octane, and there is no question about that. The way that I believe that they make it is to increase the severity of their run-through which adds to their cost and as has been testified. They have been selling gasoline at a premium price. However, one point that has not been made so far today is that what the American Oil Company does is to provide within its refinery a pool of gasoline with an average - at an average octane level. Then they take a certain small portion, a very small portion, I don't know exactly how much it is, but it's on the order of 2% to 3% to 4% of that entire pool, and they build that up into a high octane, unleaded gasoline. This leaves a resultant pool of gasoline of somewhat lower octane, which they then build up with tetraethyl lead, and - I don't know whether they are using tetramethyl, but they use a lead - tetraethyl lead. The result is that the average content of tetraethyl lead of the three grades of American Oil Company gasoline is on the order of the content of the two grades of any company that normally is operating, selling two grades of leaded gasoline. Does that tend to answer your question?

CHAIRMAN THELIN: What you are saying is that economically it would be impossible to produce, make this unleaded gasoline high enough octane to be practical unless you were also selling large quantities of leaded gasoline.

MR. MORRISON: I believe that that is true. It's a very, very, difficult question to ask and a difficult question to answer unless you want to weasel, which we don't do, to say it is economically possible. Anything is economically possible. It depends upon what people want and what they'll pay for. I feel that there is no question but what at some kind of a price somewhere you could make gasoline that was unleaded. Let me come directly to the point and answer the question that hasn't been put yet. We ourselves, out here, ask ourselves, what would it cost to provide unleaded gasoline? And we ask all of our members. Give us a number. What - how do you think you could do it? I'm not trying to be at all light about this, but with fairly light hearts they went at it to see what they could come up with, and then I began to get telephone calls back, and they said, we can put numbers down, but we can't guarantee that we can meet the requirements in octane and the requirements in quantity day in and day out that we would be required to provide, because we can't segregate, there is no point in making unleaded gas for Los Angeles County and leaded gasoline for Orange County, aside from the very fact of the unfairness of it. And you can't stop at state borders. So that what they finally concluded to me was that they are unwilling to state as engineers and as chemical engineers that there can be provided at all times adequately unleaded gasoline at any price. That's the answer.

CHAIRMAN THELIN: Are there any further questions of Mr. Morrison?

ASSEMBLYMAN BROWN: You heard the testimony earlier that the American Oil Company premium gas was priced at one cent

per gallon higher than the competitive gasoline. Is that right? Presumably that represents the minimum differential that would be required?

MR. MORRISON: Actually, Mr. Brown, although I don't know of my own knowledge, I have been told that subsequently that one cent was eliminated and that the gasoline is being sold at a price competitive with the others. I do not believe - I'm sorry, but I have to answer your question this way - I do not believe that the price at which Amoco sells its gasoline can in any way be considered to be a function of the difference in cost.

ASSEMBLYMAN BROWN: In other words, you're lending credence to the testimony we also heard that there is no relationship between the market price and the cost of production. Is that right?

MR. MORRISON: No, I'm not at all, sir. Because I believe that we have to consider that Amoco is selling three grades of gasoline and is competing in a market.

ASSEMBLYMAN BROWN: Are you familiar with the statement made by the - by Mr. Griswold earlier last month to the effect that the cost of selling unleaded gasoline would probably run about two cents a gallon?

MR. MORRISON: I heard that Gris said that.

ASSEMBLYMAN BROWN: Do you have any knowledge of the economic basis on which he made this statement?

MR. MORRISON: No, sir, I do not.

ASSEMBLYMAN BROWN: It didn't come from your industry, then?

MR. MORRISON: No, sir.

ASSEMBLYMAN BROWN: You made the earlier statement here that the products of combustion resulted in the formation of carbon dioxide and water, which would be harmless. You are referring only to these particular organic additives that we are speaking of, not the lead additives. Is that right?

MR. MORRISON: No, I'm referring only to these non-metallic additives.

ASSEMBLYMAN BROWN: The earlier testimony on the lead additives seem to indicate that the result was a substantial lowering in the lead content of the blood of the people in Los Angeles compared with other parts of the United States. So presumably, if the lead causes a reduction in the lead in the blood and you're - the organic components have no effect, then probably we would be unwise to remove either of them, since the only result could be unhealthful?

MR. MORRISON: I'm sorry, sir. I lost you.

ASSEMBLYMAN BROWN: I was trying to make a rather obtuse point, actually. I'm quite a bit concerned about this economic situation as far as removing the lead from the gasoline is concerned. You state that American Oil Company sells their unleaded gas at no difference in price. Another witness said one cent higher. Griswold has stated in some testimony that unleaded gas could be produced at two cents higher, and we've also had evidences to the effect of lead on the exhaust devices which is somewhat inconclusive. The testimony from the Ethyl Corporation was to the effect that they had not road tested unleaded gasoline on their catalytic devices, so they had no evidence on its - as to its effect on the life of the catalyst. You are

not prepared to testify on that, I presume, are you?

MR. MORRISON: No, sir, not on the lead item.

ASSEMBLYMAN BROWN: Well, I hope that the witness from the Air Pollution Control District can testify on that because the article which I read indicated that the lead had the effect of decreasing substantially the life of the catalyst. Now, you are not in a position to offer any testimony -

MR. MORRISON: Well, I've read what Gris had to say on that subject in his report and have discussed this just as an individual with a number of people and it is my understanding that there has been a problem there. However, I was rather encouraged, I say, encouraged because from a personal point of view because the least expenditure called upon to eliminate smog the better off we all are was when Mr. Griswold, in his report, stated that one company had developed a catalyst which was showing good signs of not being affected by leaded gasoline and again, expressing a personal viewpoint, I would think that this is a field which should lend itself and it should require a great deal of additional work to find out what the answer is.

ASSEMBLYMAN BROWN: Well, let me make this economic statement and see if you can concur with it. If it would cost, say, two cents a gallon to take the lead out of the gas, which would amount to around $16 per year for the average motorist, which is the figure that Griswold used, and that results in the ability to use a catalytic exhaust device which can be manufactured at an amortized cost of - which is $16 per year cheaper, then it would actually cost nothing, if we require a catalytic exhaust device within the near future which we apparently will,

it would actually cost the motorist nothing, or it would cost the consumer nothing by virtue of the cheaper device if you were to take the lead out of the gasoline. In other words, the extra cost of the gasoline would be compensated by the lower cost of the catalytic device.

MR. MORRISON: I'm familiar with that point, Mr. Brown, as I understand what you're saying is that it costs two cents to take the lead out and you could save a year of your catalyst, you would be saving "X" additional dollars and you'd be ahead and that would make good reasoning if the two cents were a proper figure. I'm not prepared to say it is. What I have already stated I stand on, that's the problem.

ASSEMBLYMAN BROWN: Yes. I bring this out to indicate the importance of trying to get a figure here, because we can't make a judgment on this, speaking as a legislator, unless we do have some figures.

MR. MORRISON: I can see your problem and we will do everything we can to give it to you. I talked to these engineers about this thing and, if you don't mind, let's put ourselves in their position. The boss says, or your folks request, how much will it cost to do this? They have to be pretty darned positive as to where this will lead them. Right not, they are not in any position to reach any conclusions at all.

ASSEMBLYMAN BROWN: This would completely disregard the health effects of the lead because if it is economically more desirable to have an unleaded gasoline in terms of its total cost to the consumer considering gasoline and catalytic exhaust device, then economically it's better business to

operate that way even if it has the - no effect on the health.

MR. MORRISON: From the standpoint of my reading, I am convinced that the health aspect of lead is not significant. If that is the standpoint of the catalyst, I am extremely hopeful, again from a citizen's point of view, that a catalyst that will not react to lead can - is close to being found and that will save money all the way around.

CHAIRMAN THELIN: Mr. Morrison, do you want to introduce Dr. Nicksic now?

MR. MORRISON: Yes. We are sure you would be interested in the relationship of the actual hydrocarbon composition of gasoline to smog. In other words, we have covered for you - we have tried to, the sulfur, the additives, the lead companies have covered the lead, but the question that came up here, Mr. Cameron alluded to it several times, what happens when you do all these other things, what about the relationship actually between the hydrocarbons in the gasoline and the smog potential of the exhaust? And Dr. Nicksic, whom I shall introduce to you in a moment, will cover the introductory material of this report at much greater length. However, it will be recalled that the obvious question has been raised as to whether there can be a change in the fuel itself to reduce its ability to make smog. Quite logically the question was raised as to whether the elimination of the most active type of hydrocarbons, those most likely to react in the atmosphere might materially help in reducing or eliminating smog. This was a normal question and it deserved adequate and serious consideration. Accordingly, about two years ago, this was in mid-July, 1959, the Western

Oil and Gas Association entered into a joint project with the Air Pollution Control District of the County of Los Angeles, the United States Public Health Service, and the United States Bureau of Mines. A great deal of work was done. This investigation supplemented studies that had been made previously and it represented a further advance in the knowledge of this subject. We cooperated in many ways. We provided all the different kinds of gasolines used. Most importantly we provided the full-time services of Dr. Stephen Nicksic, an exceedingly competent research chemist well-known in his field. Just as important and of interest to your honorable subcommittee, he has received high praise both during the work and after its conclusion, from Mr. Griswold, Los Angeles County Air Pollution Control Officer, and his colleagues. Dr. Nicksic also developed the new scientific technique which is very useful in the project. He was the recipient of a 1960 Los Angeles Clean Air Award in recognition of his outstanding work in this field. We feel that this joint research project constituted a milestone. It followed a pattern already set of close cooperation between the oil industry and the Air Pollution Control District. It proved without any doubt that two groups may start from varying points of view and come to a joint conclusion. We believe that this work answers the main questions involving the relationship of olefins in gasoline to the smog potential of the gasoline. I have the privilege of introducing to you Dr. Stephen Nicksic of California Research Corporation. He will discuss with you the relationship of olefins in gasoline to the smog potential of gasoline. I thank you, gentlemen.

CHAIRMAN THELIN: Mr. Morrison, before you go could you give me an estimate of how long Dr. Nicksic will take? We don't want to go on too far beyond five. Twenty minutes? All right.

DR. NICKSIC: I am Dr. Stephen W. Nicksic. I hold the degree of Doctor of Philosophy granted by the University of Wisconsin in 1952. I am currently employed by the California Research Corporation, Richmond, California, where I have interests in the field of nuclear magnetic resonance spectroscophin.

Controlling smog by controlling the composition of motor fuel is an attractive adea. How simple such a solution seems to be. Just give the engine a fuel that it can change into useful energy without at the same time making a smog-forming exhaust. Or better yet, give the engine the fuel that it can use without creating any exhaust whatsoever; for then the muffler and tail pipes on our automobiles would never be needed in the first place, and the exasperating replacement problem would no longer be with us. Unfortunately, it is not as simple as it sounds. Just as we cannot eliminate cancer or heart disease by passing a law against them, we cannot solve the smog problem by wishfully thinking that smog can be eliminated if only we have the right kind of motor fuel. We live in the world of reality, a world where physical and chemical behavior of matter follows certain well-defined laws which are as immutable as the universe itself. This means that science and mathematics can be used to systematically define everyday phenomena. It means that experimental observations together with logical use of cause and effect reasoning underlies our

technology. No responsible person who has used scientific methods and who has made definitive laboratory studies of his own has ever claimed that you can get rid of smog by controlling the composition of motor fuels.

As Mr. Morrison said, I will talk about the hydrocarbon composition of motor fuel and its relation to smog; and, to do this, I want to refer to Questions 5 and 6 as contained in the notice of today's public hearing. Question 5 asked if the composition of motor fuel can be altered to eliminate a substantial amount of vehicle exhaust. The answer to this question is an unqualified "No." Motor fuel contains hundreds of organic compounds which we call hydrocarbons. It is a very complicated mixture. Scientists can identify a large number of these hydrocarbons, nobody can identify all of them. There is no hydrocarbon, even if it could be produced pure without any thought of cost, that can be selected from those now identified in gasoline which would give a substantial reduction in vehicle exhaust without sacrifice of either horsepower or the physical properties which make it usable in the car you are driving today.

We could reword Question 5 to ask if the composition of motor fuel can be changed to give a substantial reduction in hydrocarbon emission. The answer to this question is also "No." No matter how you change the composition of the fuel, the amount of hydrocarbons in the exhaust will be substantially the same with other factors being equal. You can reduce exhaust hydrocarbons by keeping your engine tuned, by eliminating jackrabbit starts, and by letting your engine breathe more air

(increase the air/fuel ratio) when it burns fuel. This gives more complete combustion. You can reduce hydrocarbons by driving less, but you can't do it by fuel composition. On the other hand, you can change fuel so as to change, to some extent at least, the kind and distribution of hydrocarbons in the exhaust. If the kind of hydrocarbon in the exhaust is important in smog, then it is fitting and proper to study fuel composition effects, using sound scientific methods.

We will, therefore, discuss Question 5 as though it were worded "How is the composition of motor fuel related to the smog-forming potential of auto exhaust generated while operating motor vehicles in a certain prescribed manner?" When gasoline is burned in your car, which is tuned properly and operated in a reasonable manner, most of it is converted to carbon dioxide, carbon monoxide, and water. This conversion to oxides of carbon and water takes place with any fuel you use. Automobile engines, however, like our own digestive systems cannot use all of its fuel at 100% efficience so that some of this fuel is either discharged through the exhaust pipe without being burned at all or else it is discharged after being changed by heat and pressure in your engine to other hydrocarbons which can and do make smog when sunlight and weather are favorable. These changed compounds are mostly olefins. A small percentage of the gasoline which passes through the engine without being burned also consists of olefins but of a different kind than those which were formed by your engine. Now it has been known for many years that olefins as a class are more reactive than many other hydrocarbons so that they are considered to be very important

in the reactions leading to smog. Of course, remember, reacting rapidly does not necessarily mean the same thing as eye irritation or plant damage, but it does focus attention on these compounds, because, before smog can be formed, the photochemical reactions must take place; and we know that the olefins are among the first to react.

To review briefly, some olefins get into the air because your car just can't burn all the gasoline, and another much larger quantity of olefins of a different kind get into the air because they are formed by your car in the combustion process no matter what fuel you use. The evaluation of the importance of the olefins in your fuel can be simplified if we just look at the smog-forming potential of the exhaust produced from burning fuels of varying olefin content. But the picture is not as simple as that. Even the olefins which are present in the gasoline are not all the same kind. They differ in their structure, in their reactivity, and in the products they form on being irradiated with sunlight. They differ depending on the refining process, on the source of crude oil, the blending practice, and other factors. Furthermore, compounds other than olefins react; and, if you remove olefins from gasoline, you can replace them with compounds that also react photochemically in such a way that would make them worse than the olefins in the first place.

Recognizing the reactivity of the olefins and with preliminary information on the possible effect of olefins in the fuel, the Los Angeles County Board of Supervisors passed in July of 1959, Rule 63, bearing on the olefin content in

gasoline as reflected by fuel bromine number. Coincident with the passing of Rule 63, a Board order was handed down which paved the way for an extensive program of further study on the practical effect of bromine number control on the Los Angeles smog. This program was a cooperative venture between the Los Angeles Air Pollution Control District and the Western Oil and Gas Association, utilizing the advice and direction of the U.S. Public Health Service and the U.S. Bureau of Mines through their participation on a steering committee formed to guide the experimental program. It was recognized that, if olefins were to be removed, they would be replaced by other hydrocarbons so that other aspects of fuel composition were to be studied in addition to the specific item of fuel olefins. I want to describe this program briefly before discussing the results and the practical effect which bear on Question 6 of your agenda, relating to the feasibility, practicability, or necessity of standards governing the composition of gasoline.

For the program, six test fuels were supplied by the Western Oil and Gas Association. Four of these were so-called normal fuels of different bromine number but otherwise quite similar. The other two were designed to have the same bromine number as one of the normal fuels, but to cover other aspects of fuel composition. The relative smog-forming characteristics of these fuels were evaluated through the use of the Los Angeles Air Pollution Control District's environmental test facilities. Over 100 separate irradiation test experiments were made requiring extensive eye irritation tests, plant damage studies, and numerous chemical and physical measurements designed to

fully study the photochemical reactions. As previously mentioned, the U. S. Bureau of Mines and the U. S. Public Health Service also participated in this program through frequent consultation, close liaison, and membership on the steering committee. When the program was finished, a complete joint report of the findings, together with a summary report of the steering committee, was written. The joint report entitled, "Gasoline Composition and the Control of Smog," was unanimously approved by all participants in the study. We will file a copy of this report with you at the end of this hearing. There are over 160 pages of data and discussion. This report is based on the most definitive study of the effect of fuel composition on the various aspects of smog ever carried out. Now to discuss briefly the findings of this program:

The findings are condensed for you in a "Summary Report of the Steering Committee," which is in the front part of the complete joint report. I hope you will find time to read this section very carefully. In this summary, the four most common manifestations of smog were considered, namely, eye irritation, damage to vegetation, visibility reduction, and the oxidizing potential of the atmosphere. For the latter three items, the effect of fuel bromine number either did not exist or was not important enough to discuss further. As for eye irritation, there was a definite tendency for more eye irritation with higher bromine numbers, if certain other composition factors were held constant. This was generally in conformance with the earlier findings of the Los Angeles Air Pollution Control District, although the effect was smaller than suggested by

earlier studies. With the complete picture, which takes several hours to cover fully, and with careful consideration of the practical effect of bromine number control on the Los Angeles community, the steering committee made recommendations which I will cover in discussing Item 6 of your agenda.

Item 6 asks, according to my interpretation, if the control by law of fuel composition is feasible, practical, or necessary. A reasonable measure of control is certainly feasible. Composition of fuel is controlled daily at the refinery in meeting many specifications such as volatility so that your car will start, octane number to eliminate pinging, and many others. Rule 63, today, effectively limits the olefin content of gasoline marketed in Los Angeles County. Therefore, certain controls are not only feasible but in practice. Other controls could make it necessary for you to stay home instead of going to the football game because not enough fuel was available for everyone. Or you might not be able to start your car, or to go up a hill without severe pinging. Are these controls practical or necessary? It was the feeling of the joint committee that standards maintaining the bromine number of the "gasoline pool" at current levels in Los Angeles were practical, desirable, and necessary in Los Angeles because large increases in the olefin content could result in a noticeable increase in eye irritation. On the other hand, a decrease to the lowest practicable limit would not be readily perceived by the public; and the limited benefit might even be nullified by counterbalancing effects of other fuel composition factors. A control on some of these other composition factors could not be justified from the

limited data on this aspect of the study. In arriving at this conclusion, the committee in the summary report took into consideration certain practical matters. One of these was the imminence of exhaust controls. The State of California has already passed legislation requiring exhaust controls on all motor vehicles within a specified time after such controls become available. It seems reasonable that the best way to get the job done is to burn all the hydrocarbons that are emitted from the vehicle. In this way the motorist does not have to pay twice for getting the job done, and he can see some genuine results from the money he spends.

The cooperative study was concerned only with the Los Angeles situation. The practical effect of fuel bromine number on a statewide basis cannot be predicted. Experimental design of the cooperative study reflected the fuels currently sold in Los Angeles County, it reflected the Los Angeles driving pattern, and factors relating to time of irradiation, intensity of irradiation, wind speed, hydrocarbon concentration, etc. Extrapolation of these findings to a statewide basis requires careful consideration and further study. Premature action will only mean that the motorist will spend his money for something that he can neither see nor feel, and for a "benefit" that cannot be demonstrated to exist.

So far we've been talking about gasoline. Just a word or two about diesels seem appropriate. As far as we know, there has never been any systematic investigation of the effect of fuel composition on the smog-forming potential of irradiated diesel exhaust. Since the concentration of contaminants in

diesel exhaust is low, it is generally felt that diesels contribute little to the Los Angeles smog picture. However, you and I know about the smoke and odor which the diesel bus or truck in front of you sometimes gives.

The best available evidence is that a hydrocarbon fuel can be tailored to minimize smoke and odor but this would have to be done for practically every vehicle on the road. Every diesel engine is a law unto itself. Each engine is different even from another one of exactly the same make, age and type of service. The smoke and odor depend on injector design, combustion chamber design, whether it is a two or four cycle engine, on the operator habits, on how long the engine has idled, on the load and on many other factors. For each situation an optimum fuel probably exists but to provide this fuel is an obvious impossibility.

Thank you for letting me talk today. I will be glad to answer any questions. I hope I haven't taken up too much of your time.

CHAIRMAN THELIN: No, that was very fine, Dr. Nicksic. Does anybody have any questions? I guess that's all. You must have done a very good job. Or else it is too late in the day, I don't know which.

DR. NICKSIC: I'm afraid it is the latter.

CHAIRMAN THELIN: Thank you very much, doctor.

DR. NICKSIC: I would like at the same time to file a brief summary on the acid heat reaction which was brought up several times during the day and I think you will realize that there is very little testimony anywhere in scientific

literature on this test.

CHAIRMAN THELIN: If you will just give it to the sergeant here, why we will add it to our collection. We're massing quite a volume here today.

Our last witness will be Mr. Lewis Fuller for the Air Pollution Control District of the County of Los Angeles.

MR. FULLER: Mr. Chairman and members of the Committee. My name is Lewis J. Fuller, Chief Deputy, Air Pollution Control Office of Los Angeles County. And I am well aware of the time and I will attempt to do this in five minutes.

It is the understanding of the Air Pollution Control District that the purpose of this committee hearing is to determine the need for legal prohibitions on the use of various additives in gasoline and any companion need for standards regulating the basic composition and characteristics of the fuel itself.

Since proposals to accomplish this end have been advanced as a means of combating smog and of improving California air quality, it is appropriate that some examination be directed to the basic nature of the Los Angeles smog problem and its relevance to motor vehicle operations.

I think I will skip here, gentlemen, as rapidly as I can. We have, in the past few years been able to remove some 4600 tons of contaminants from our atmosphere each day. This has been accomplished by very rigid controls from stationary sources.

The California Department of Public Health has determined that an 80 percent reduction in the atmospheric loading of

hydrocarbons in the Los Angeles atmosphere will be necessary to restore air quality to 1940 levels and to maintain it at that point until 1970. This reduction forms the basis for the air quality and vehicular emission standards which have been promulgated by that body under the direction of the California State Legislature.

Within the context of these background remarks we might now examine the relationship between gasoline composition, vehicular contaminant emissions and demonstrable air quality problems.

Gentlemen, this has been covered a number of times today, so I won't go into this point.

The more than 3,000,000 gasoline powered vehicles in Los Angeles County consume more than 6,000,000 gallons of gasoline daily. The resulting emissions of air contaminants are 1200 tons of hydrocarbons; 8900 tons of carbon monoxide; 330 tons of oxides of nitrogen; 25 tons of sulfur oxides; and 16 tons of lead.

The maximum levels of these contaminants which have been found in the Los Angeles atmosphere and again, let me repeat, maximum: carbon monoxide, 72 parts per million in downtown Los Angeles in November of '59 and December of '60. Total hydrocarbons 4.66 parts per million in El Segundo in August of 1957. Lead, inorganic lead, 26.6 micrograms per cubic meter, which is a 24-hour average in Pasadena in October of 1954. Sulfur dioxide, 2.49 parts per million in El Segundo in June of 1957, and nitrogen oxides, 3.93 parts per million in downtown Los Angeles in January, 1961.

I don't think it is necessary to read about the basic

components of gasoline. You have heard enough of that, I think, today.

It has already been indicated that modern gasoline also contains a variety of chemical and metallic additives designed to impart some specific quality of property as a fuel. The District has extensive interest but no current evidence that would suggest that the presence of these materials in gasolines are resulting in or contributing to the occurrence of any objectively verifiable air pollution problem. We have been unable to find any direct relationship between the occurrence of any manifestations and the presence of these additives in gasoline.

There remains, therefore, at least three questions which properly can be raised in respect to additives:

1. Do they result in or contribute to the occurrence of any public health problem?
2. Do they in any way hamper controlling the emissions of the important contaminants from motor vehicles?
3. Does their use in gasoline contribute directly or indirectly to photochemical "smog"?

In response to the first question, the Los Angeles Air Pollution Control District is essentially an engineering organization with no competence in the field of medicine or public health. We have no independent counsel or assistnace to offer this committee on this subject.

In response to the second question, it has been reported that the use of lead additives in gasolines has hampered the development of catalytic type control devices which might be used for the control of exhaust emissions.

In response to the third question, it is very possible that the use of lead in gasoline adds to the smog as manifested in Southern California. Without the use of counter additives, lead, used to raise octane, would cause fouling of spark plugs, thus leading to increased amounts of hydrocarbon losses. From an air pollution standpoint, unleaded gasoline of an acceptable octane rating would be preferable to leaded gasoline.

It is requested that a recent report authored by Mr. S. Smith Griswold, Air Pollution Control Officer, Los Angeles County, be received and made a part of the record of this hearing. The pertinent section of that report are on pages 11, 12, and 13. You have a copy of that report.

CHAIRMAN THELIN: It will be so received.

MR. FULLER: Thank you. One final aspect of gasoline remains to be examined - that of the residual materials found in gasolines and which are native to the crude oil from which gasolines are produced. The primary material of this sort found in California gasolines is sulfur. Since California crude oils are comparatively high in sulfur content, some of the sulfur finds itself into the gasolines refined from that crude oil.

Data published by the Ethyl Corporation in its Annual Review of Gasoline Quality shows that during the year 1959 the average sulfur content of gasoline sold on the West Coast was 0.096% by weight for regular and 0.039% by weight for premium grades. And there follows quite a discussion by the various percentages using the same assumptions with the Bureau of Mines data, the average sulfur content of gasolines marketed during the summer of 1960 becomes 0.035% for Southern California and

0.047% for the national average. From these data, it is apparent that much of the gasoline marketed now is close to or below the sulfur content proposed by AB 2335. Using 0.061% by weight as the average sulfur content of gasoline marketed in the State of California, it may be shown that reduction to 0.050% would reduce the maximum emissions of sulfur dioxide possible as the result of the daily combustion of 15 million gallons of gasoline from 57 to 47 tons per day, a net reduction of only 10 tons per day of sulfur dioxide for the entire State of California.

In conclusion, I would like to state that the elimination of some 4600 tons of air pollution daily in Los Angeles County has resulted from the enactment and enforcement of the most stringent rules and regulations which have ever been adopted anywhere. There rules and regulations were enacted with the primary purpose of eliminating air pollution at its source.

The District is fully aware of the research presently being conducted by the United States Public Health Service and the State Department of Public Health to determine the effects of air contamination on the health and welfare of the public. The District fully supports this research and is contributing its facilities and technical competence in every way possible. At the present time the District is assisting in an animal exposure project in conjunction with the University of Southern California, sponsored by the United States Public Health. This project is being sponsored by the Surgeon General to provide a basis for a report to Congress within the next two years on the effect on human health of the discharge of harmful exhaust gases.

When final determinations have been reached by public

health authorities with respect to emissions from motor vehicles, whether from additives or any other substance, the Air Pollution Control District will join the State Department of Public Health in the preparation of standards which will provide for the ultimate protection of the public.

I am sorry, Mr. Chairman and gentlemen, that Mr. Griswold is not here because I suspect that I may be asked questions which I am unable to answer, but I will do my best.

CHAIRMAN THELIN: Well, we can only ask you to do your best. We, of course, are always happy to have Mr. Griswold here. Are there any questions of Mr. Fuller?

ASSEMBLYMAN BROWN: I don't like to belabor this, Mr. Chairman, but I was very much interested in this question of the effect of lead on the catalytic devices. Do you have - are you able to testify on that subject?

MR. FULLER: I have the report, sir, which you have in front of you. The relevant portions there are on pages 11, 12, and 13. This was the report which Mr. Griswold just made after his return from Michigan, where he visited those manufacturers.

ASSEMBLYMAN BROWN: Well, he states here that the total life of the catalyst is substantially reduced. Some estimates indicate that the same catalyst could well perform for as well as 50,000 driving miles if exposed only to the exhaust from non-leaded fuels as contrasted to 12,000 miles if the vehicle is operated on leaded gasolines. In other words, it seems to me that we are saying that the device will last, well, we'll say essentially one year, which would be 12,000 miles in driving or it would last for four years, if it were on unleaded

gasolines and if the cost of these devices runs around $75 each or somewhere in that vicinity, we could be saving somewhere in the neighborhood of $300 by - well, we could be saving in the neighborhood of $75 per year - we'll say, $60 per year, if we used unleaded gasoline and the unleaded gasoline would cost us $16 per year. In other words, we could save ourselves about $40 per year in the cost of devices if we used unleaded gasoline. That arithmetic is very rough, but -

MR. FULLER: That is the report, sir, which Mr. Griswold made upon his return.

ASSEMBLYMAN BROWN: Well, that, of course, assumes the two cents per gallon cost for removing the lead which is open for question because the industry hasn't been able to testify as to the cost.

MR. FULLER: That's correct.

ASSEMBLYMAN BROWN: This is the only point I wanted to make, Mr. Chairman.

CHAIRMAN THELIN: That's contained in Mr. Griswold's report here, so the record will speak for itself in that regard. He discusses the whole thing.

I guess that is all, Mr. Fuller, thank you for appearing.

Now, Mrs. McDonald, you requested rebuttal time here. I'm sorry to say, I just don't think we can go into rebuttal period, somebody else will want to rebut the rebuttal if we do that, and we will be here for a period that no one here could estimate what it would be. The Committee has to go to work in San Diego tomorrow, so it is kind of anxious to be on its way. If Mr. Phillips has something new he wants to add, maybe we can give

him about two minutes, but we don't want to go into a rebuttal. If you want to file a written report rebutting these statements, of course, we will be open in the future for that and just mail it to the committee office and it will all go into the committee's files for analysis and evaluation when we make our report. Would that satisfy your requirements, realizing that we can't have a rebuttal? All right.

Thank you very much, Mr. Phillips, and thank you all for attending. This concludes the meeting.

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